MECHANICAL ENGINEERING

Published by The American Society of Mechanical Engineers

VOLUME 60 NUMBER 10

Contents for October, 1938

Published monthly by The American Society of Mechanical Engineers. Publication office at 20th and Northampton Streets, Easton, Pa. Editorial and Advertising departments at the headquarters of the Society, 29 West Thirty-Ninth Street, New York, N. Y. Cable address, "Dynamic," New York. Price 60 cents a copy, $5.00 a year; to members and affiliates, 50 cents a copy, $4.00 a year. Postage to Canada, 75 cents additional, to foreign countries, $1.50 additional. Changes of address must be received at Society headquarters two weeks before they are to be effective on the mailing list. Please send old as well as new address. . . . By-Law: The Society shall not be responsible for statements or opinions advanced in papers or . . . printed in its publications (B13, Par. 4). . . . Entered as second-class matter at the Post Office at Easton, Pa., under the Act of March 3, 1879. . . . Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized on January 17, 1921. . . . Member of the Audit Bureau of Circulations.


Courtesy Westinghouse

Battery of Presses for Stator Punchings

Volume 60
No. 10

MECHANICAL ENGINEERING

October
1938

GEORGE A. STETSON, *Editor*

A.S.M.E. Preprint Plan

DURING the summer, the Executive Committee of the Council of The American Society of Mechanical Engineers, gave its approval to a plan to establish a partial preprint service for papers presented at Society meetings. Under conditions as they exist at present the plan will provide only for preprints of papers scheduled for publication in Transactions, about 100 per year, but this is an important step toward a complete service. Details of the plan will be found on page 787 of the A.S.M.E. News Section of this issue. The only effect that adoption of the plan will have on Society publication procedure as it now exists is that papers published from now on will appear in the monthly issues of the Transactions complete with discussion *after* they have been presented. Up to the present time, most Transactions papers have been published *before* they were presented, and hence discussion has been published separately several months later. In addition to setting up the partial preprint service, the new plan has the advantage of publication of a paper with the discussion of it in the same issue. It will take several months to clean up an accumulation of papers and discussions presented at previous meetings. The plan goes into effect for the 1938 Annual Meeting.

What Is an Engineer?

DEFINITIONS of the terms "engineer" and "engineering" have been written by many persons and organizations. Most famous, perhaps, is Thomas Tredgold's definition of engineering, found in the charter of the Institution of Civil Engineers. Many modifications of Tredgold's definition have been attempted, and on it many definitions of the term engineer have been based. Since the turn of the century, the most common modifications have included some reference to economics and the management of enterprises based on engineering, in addition to "the great sources of power in nature." Some years ago the Engineers' Council for Professional Development published what it called a "minimum definition of an engineer." In this definition educational qualifications were stressed, as the purpose was to provide a basis for a requirement for engineering-society membership. The most recent contribution to the growing list of definitions has been made by Karl T. Compton, with the help of members of the E.C.P.D. Committee on Engineering Schools, at the request of Arthur S. Watts, of the Institute of Ceramic Engineers. The definition is: "An engineer is one who, through application of his knowledge of mathematics, the physical and biological sciences, and economics, and with aid, further, from results obtained through observation, experiences, scientific discovery, and invention, so utilizes the materials and directs the forces of nature that they are made to operate to the benefit of society. An engineer differs from the technologist in that he must concern himself with the organizational, economic, and managerial aspects as well as the technical aspects of his work."

It will be noted that Dr. Compton's definition is more specific than many others. It names certain branches of knowledge that the engineer must apply; it takes cognizance of research, practice, and new discoveries; and it differentiates between the technologist and the engineer. Among the branches of knowledge named by Dr. Compton the ones most usually thought of in connection with engineering are mathematics and the physical sciences. The addition of economics is in line with a time-honored conception of the engineer frequently referred to as "one who can do for one dollar what any other person can do for two." Few there are today who do not recognize the engineer as an economist," as Henry R. Towne expressed it half a century ago. But "biological sciences" appears in the definition for the first time, if memory does not fail. As basic knowledge for engineering, the biological sciences will be an unfamiliar addition to many engineers. What Dr. Compton meant to include was explained by him in an address delivered before The American College of Physicians, an abstract of which appeared in the June issue of Mechanical Engineering. It is in line with the broadening of the field of engineering.

Some controversy is likely to develop over the distinction made in the definition between the technologist and the engineer. Undoubtedly, it is a good thing to make this distinction, although the two terms will continue to be used without discrimination to refer to both kinds of persons. Probably many technologists, according to the definition, will resent having the title "engineer" taken away from them. Many others will not know just where they do stand. It is hard to escape the "organizational, economic, and managerial" aspects of work no matter how modest they may be, and it is not always easy to decide just when a growing concern in them excludes almost completely concern for technical aspects. But this new element in the definition is in line with the broadening responsibilities that the profession of engineering is taking on more and more, and with the pattern of indi-

vidual development which the average engineer undergoes, as was brought out clearly by the study of the 1930 earnings of mechanical engineers conducted by the A.S.M.E. committee on economic status.

Engineering has come a long way since Thomas Tredgold's day, and as a result frequent changes are needed in definitions of the term engineer. Dr. Compton has tried to bring the definition up to date. The more one thinks about it the more one is inclined to admit that this definition is an excellent one.

Salute to Providence

IN RETURNING to Providence, R. I., for its 1938 National Fall Meeting, The American Society of Mechanical Engineers finds itself in an environment particularly suited to its own traditions. For more than a century Providence has developed the men and machines upon which the industrial supremacy of this country rests. It has provided an example of the paradox that man increases his own skill by imparting it to machines. It was at Providence in 1850 that Joseph R. Brown built a linear dividing engine that became the first automatic machine for graduating scales. The following year he brought out the vernier caliper, which permitted readings to be made to the thousandth part of an inch, and in 1856 his great contribution to industrial standardization was made in the form of the Brown & Sharpe wire gage, later known as the American wire gage. Finally he developed the micrometer caliper in practical form.

Out of the clock business which Joseph Brown and his father David organized in 1833 came the need for accurately cut gears which brought forth the gear cutter, the formed milling cutter, and the system of involute gearing. The laborious process of forming the spiral flutes in a twist drill with a rattail file, witnessed in a Providence shop, led to the development of the universal milling machine. The turret screw machine, the cylindrical and the universal grinders, and the automatic gear cutter were among other machines coming out of Providence, during the nineteenth century.

Interchangeable-parts manufacture in Providence, as in other New England industrial centers, demonstrated the need for gages and gave rise to their widespread use and manufacture. Here the fruits of precision, grown from the skilled-mechanic stock, are harvested in the form of better machines and products and that combination of increased production and decreased costs that has been the foundation of this country's industrial progress and wealth. And most important of all, perhaps, has been the group of able and skilled men that flourished in the environment of Providence and went forth to build up other enterprises in other industrial centers.

Providence, today, enjoys the prestige that a reputation for quality, precision, and skillful workmanship won for her. Her manufacturing plants have served the textile industries that are located in the Blackstone Valley and the textile centers of eastern Massachusetts and Rhode Island. It was here that Corliss built his famous engines that would never have been successful without the superior quality of Providence workmanship. Here also craftsmanship of a different character flourished and provided the generations of workers who have made the city and its neighboring towns famous throughout the world for their jewelry and silverware industries. Here also engineers applied their technical knowledge to certain phases of the insurance business, with notable contributions to hydraulics, to fire protection, and to structures to withstand earthquake shock.

New England skill and ingenuity, New England thrift and industry, New England enterprise and progressiveness flower brilliantly in Providence. Here where men and machines develop side by side are to be found striking examples of the beneficent effects of the machine age. Mechanical engineers in attendance at the 1938 A.S.M.E. National Fall Meeting can afford a generous salute to Providence.

Preparing for the Unexpected

PROF. A. B. NEWMAN, chairman of the Chemical Engineering Education Committee, in a report on "Development of Chemical Engineering Education in the United States," says that in 1910 there were 869 chemical-engineering students, or about 3.7 per cent of the students then in attendance at engineering schools. In 1937–1938 this number of chemical-engineering students had increased to 12,556, or 23.7 per cent of the total. Everyone knows that chemical engineering has made huge strides in the quarter century covered by these figures, but the growth in the number of embryo chemical engineers has placed a heavy burden on the resources of the colleges, and there are indications that graduates in chemical engineering are finding it harder to get the kind of jobs they want.

Apparently most of those who discussed Professor Newman's report when it was presented were more concerned with the quality and content of the curriculum than they were about excessive numbers, although C. M. A. Stine, of E. I. du Pont de Nemours and Company, suggested that a course in chemical engineering might be immensely useful to a man who wants to follow a general business career. This observation has been made frequently in respect to engineering education in general, and is significant enough to justify emphasis and to point the way toward a sound policy for higher education in general. That way lies in taking an essentially broad view of educational objectives in general, a view, fortunately, with which most engineering educators are familiar and in accord.

The best equipped man is the one who can turn whatever specialized and fundamental knowledge he may have to profit in whatever situation in life Fate places him. What will count most in such a situation will be a trained intelligence, competent to deal with any emergency, rather than a high degree of specialization in some field perhaps destined for early obsolescence or a prey to business depressions.

MOTOR DRIVES *and* ELECTRIC CONTROLS on MACHINE TOOLS

By B. P. GRAVES

BROWN & SHARPE MFG. CO., PROVIDENCE R. I.

IN 1904 the first constant-drive milling machine was announced and with it came an opportunity to use motor drives on machine tools. Cone pulleys had been eliminated and the new gear train with its constant-speed drive shaft made a convenient design for the application of an electric drive. Since then the demand for motor drives has been steadily increasing and has become so great that many modern tools have been designed and can be purchased only as electrically driven and controlled machines. Where we once thought of motors and controls as extras to be hung on or added to a machine, we now consider them as integral parts of a machine and are carefully planning for them as new designs are laid out.

Because of the rapid developments and active interest in electric machines, this paper is written to describe some of the functions which have been and can be accomplished with electrical designs. The paper is divided into three sections and will give illustrations of some of the electric drives and controls used by machine-tool builders in New England.

Section 1 discusses the general reasons for the increasing use of electrical equipment on machine tools and gives numerous examples of the features and functions which are possible with electric machines.

Section 2 considers some of the practical aspects of the design of electrically driven and controlled machines and comments on some of the problems encountered and their possible solutions.

Section 3 describes in some detail a milling machine and a grinding machine, each of which is electrically controlled.

1 ADVANTAGES OF ELECTRIC DRIVES

In very general terms, the primary reasons for the increasing use of electrical equipment on machine tools can be listed as: (*A*) It is comparatively easy to flex a cable or to conduct electricity around a corner. (*B*) Very little effort is required to press a button or to make or break a control circuit. (*C*) It is surprising how many machine functions can be linked together and controlled by a single switch. These reasons are explained and illustrated by practical examples in the following:

(*A*) *Conducting Electricity Around Corners.* Whenever a power-driven unit is located on a member which has a compound movement or is located in some corner of the machine well removed from the main driving shafts, it is very convenient to use an individual motor drive mounted directly on the unit. Where it would be difficult to run power shafts or belts to the unit, it is simple to lead a cable to the desired point. A few interesting cases are the following:

(*a*) The headstock of a grinding machine is mounted on a swivel table, as shown in Fig. 1. This table must traverse with the sliding table. There is no more satisfactory way of getting power to the headstock than by mounting a motor directly on the headstock.

(*b*) The spindle head of a cutter grinding machine must swivel about a vertical axis, must be raised and lowered, and must be moved in and out with the cross slide. A motor mounted on the head makes the simplest solution to this spindle drive.

(*c*) Fig. 2 shows a dust-exhaust attachment for a surface grinder. With the fan or blower mounted directly on the motor shaft a very compact unit is obtained. No mechanical power take-off from the machine is necessary and the attachment need not be mounted in any fixed position relative to the machine. It is also possible with a unit drive to move the attachment from one machine to another.

(*d*) In many machines, there is no constant-speed shaft available to drive the lubricating pump or there are no shafts in the base which do not start and stop with the table or some unit in the machine. A motor-driven lubricating pump aids design in such machines.

(*e*) A high-speed boring head is desired in one of the eight stations of a Bullard Mult-au-matic machine. It would be awkward to insert speed-up gears to drive the spindle; however, it is simple to use an individual direct-connected motor, as shown in Fig. 3.

(*f*) The screw-slotting attachment of an automatic screw machine is driven by a small motor mounted directly on the unit, as shown in Fig. 4. Socket plugs are provided on machines so that attachments may be readily mounted in place or removed if not needed.

All these examples are cases where it is difficult or awkward to obtain a mechanical drive but comparatively easy to mount a motor for direct drive. The great convenience of us-

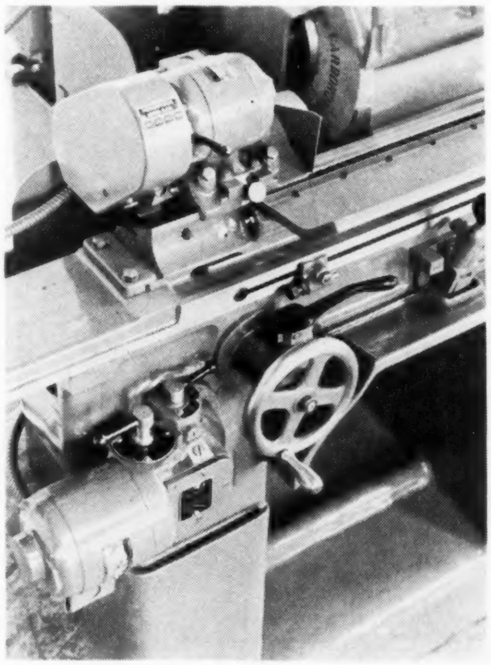


FIG. 1 MOTOR MOUNTED ON GRINDING-MACHINE HEADSTOCK

Contributed by the Machine Shop Practice Division for presentation at the Fall Meeting, Providence, R. I., October 5-7, 1938, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

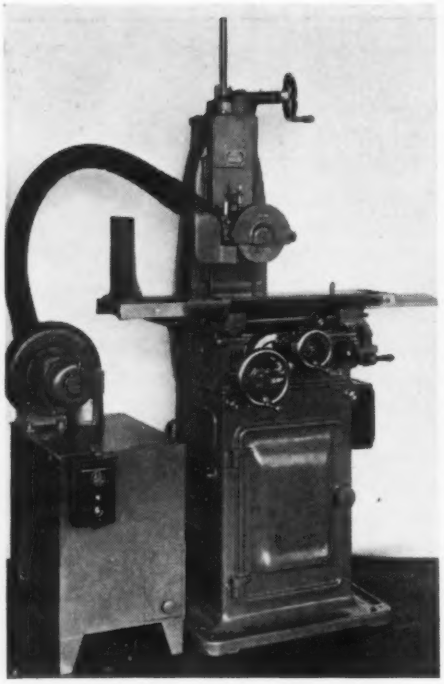


FIG. 2 MOTOR-DRIVEN DUST-EXHAUST ATTACHMENT

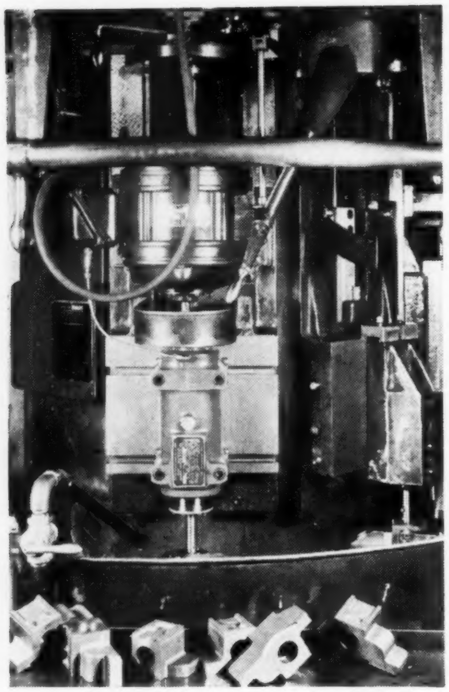


FIG. 3 HIGH-SPEED BORING HEAD ON A BULLARD MULT-AU-MATIC BORING MACHINE

switch will center controls in the cross-feed handwheel or in individual control knobs. (6) With knob control, a selector switch permits the headstock and table to be started by the same knob or by separate knobs.

Manufacturers prefer to get away from special machinery and to use standard machines which are versatile in the work they can produce and which can be readily set up or changed over. We believe electrical controls and drives help in the design of such standard machines.

(C) *Interrelation of Controls.* Perhaps the greatest advantages of electrical controls result from the interconnection of controls and the linking together of machine functions. By tying together various members in a control circuit, it is possible (1) to simplify the operation of the machine so that production parts may be machined with a minimum number of control movements being required of the operator; (2) to have dual control or start-and-stop stations wherever they are desired; (3) to include many safety features on the machine which protect both the operator and the machine; and (4) to include attachments and to make changes which add new movements or operating cycles without seriously changing the standard machine. A few examples will explain these possibilities.

Operation. (*a*) In a milling machine setup for a production cycle, the operator presses a start button. All action from this point on is started by table dogs which make and break control circuits. The table moves toward the work at a fast travel rate and trips into feed. The spindle starts with the feed and con-

ing small motor drives for units of a machine will undoubtedly lead designers to adopt a great number of these drives.

(*B*) *Ease of Control.* Electrically controlled machines are easy to operate. Little effort is required to press a button and setting up is quite simple when it is done by turning switches. With mechanical controls, it is often difficult to keep hand-lever forces below the 15-lb limit which we set for convenient operation. This is especially true when clutches must be disengaged while the machine is cutting or under load. In electrical designs, power for various functions is supplied by solenoids or motors and all the operator does is make or break a control circuit by pressing a button or snapping a switch.

Machine operation is made simpler and faster by interconnecting various control devices and centering control in a single switch. This will be discussed more completely under the title "Interrelation of Controls."

Setups may be made quickly where the desired operating cycle can be secured by turning selector switches. A few of the setup changes obtained with such switches are described briefly in the following:

Milling Machines. (1) The coolant pump is controlled by a selector switch, as shown in Fig. 5. (2) The direction of spindle rotation is set by switch, also shown in Fig. 5. (3) A three-position selector switch, shown in Fig. 6, gives the choice of having the spindle run continuously, run only when the table is moving, or run only when the table is moving at the feed rate. (4) A foot or treadle starting switch, shown in Fig. 6, may be made active or dead by turning a setup switch.

Grinding Machines. The controls of a grinding machine are shown in Fig. 7. (1) A selector switch makes arrangements for plunge cutting or traverse grinding. (2) If traverse grinding is to be used, a three-position switch may be set for long table dwell, medium dwell, or no dwell. (3) A fast or slow table movement for hand operation is chosen with a selector switch. (4) One of the three truing or slow-grinding speeds is available through a three-position switch. (5) A setup

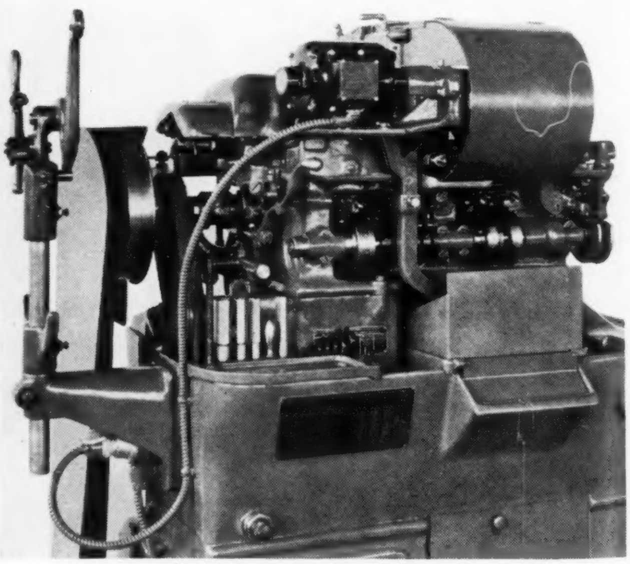


FIG. 4 MOTOR-DRIVEN SCREW-SLOTTING ATTACHMENT ON AN AUTOMATIC SCREW MACHINE

tinues until the table drops into fast travel in reverse; when it comes to rest at its original starting position the cycle ends.

(*b*) The controls of a grinding machine may be so connected that a partial turn of the cross-feed handwheel will bring the wheel slide forward in quick travel for 2 in. and will start the headstock, table, and coolant pump.

(*c*) A reverse motion of the handwheel withdraws the wheel slide, stops the headstock, table, and coolant pump, and applies a brake to the headstock.

(*d*) To true the grinding wheel the headstock should be stopped, the table should move at a very slow speed but should not dwell at the ends of its movement, and coolant should be flowing. A single switch is turned and all these functions are obtained. When the switch is turned from "true" back to "grind" all original settings are restored and no time is lost in resetting speeds, feeds, or controls.

Dual Control. It is a simple thing to provide more than one control station, since switches can be placed in parallel or series and located wherever they are most convenient. Frequently on milling machines an operator would prefer to have his hands free for other tasks, thus wanting a foot or treadle switch with which to start the machine cycle. Such treadle control is readily provided on an electric machine, as shown in Fig. 6. An excellent example of balanced design is shown in Fig. 8; dual control stations in this Heald Bore-Matic permit the operator to control the machine from either end of the table.

Safety. (*a*) Machines are frequently injured by failures in lubricating systems. An electrically controlled machine can be protected from such failures by a simple plunger device in the oil line. When oil pressure gets high, indicating stoppage, or low, indicating failure, the control circuit is opened and the machine made inoperative.

(*b*) Machines having change-gear cases can be so wired that the control circuits cannot be completed unless the doors are closed. No one can accidentally start a machine while the operator is changing gears.

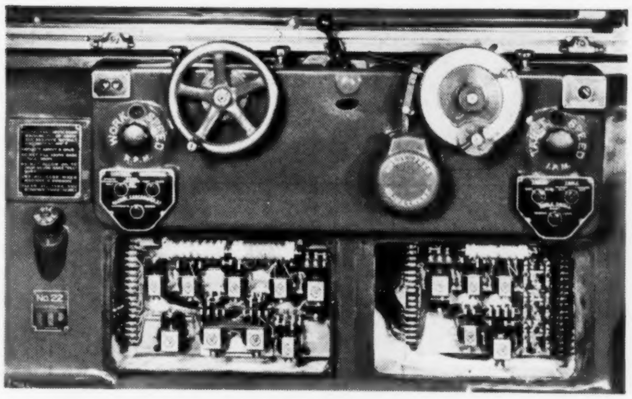


FIG. 7 SETUP SWITCHES ON A PLAIN GRINDING MACHINE

(*c*) It is also possible to open the control circuits or make the machine dead whenever a cover to a control panel is removed.

(*d*) As a milling machine completes an automatic cycle, the table stops while the stop dog is still depressing a directional stop plunger. In starting a work cycle, the operator should press the fast-travel-right button. If he presses any other button in the post no trouble will follow. If the feed-right button is pressed by mistake the table will start off at a slow feed rate. The operator observing the slow movement can press the fast-travel-right button or can let the machine continue at the feed rate. If either the fast-left or feed-left button is pressed by mistake nothing happens because these control circuits are held open by the table dog. Thus a safety feature is provided and an operator has no fear of pushing the wrong control switch as he starts his machine.

(*e*) When a grinding machine is set for plunge cutting, a control circuit is opened which makes it impossible to drive the table of the machine by power.

(*f*) When set for truing, the cross-feed handwheel control is made ineffective and it becomes impossible to move the wheel slide in fast travel.

Changes and Attachments. There are always cases where special cycles or functions are desired on a standard machine. An electrically operated and controlled machine can frequently be changed over with shifts in wiring and the addition of a few standard switches. In most cases a mechanical machine would require extensive design changes before the same functions could be obtained.

(*a*) In a standard milling machine the spindle starts and stops at various points in the table cycle but does not change its direction of rotation. In unusual setups where it is desired to have the direction of spindle rotation dependent on the direction of table feed, the interlocking of the two motors can be accomplished by change of the spindle-motor contactors (substituting one switch

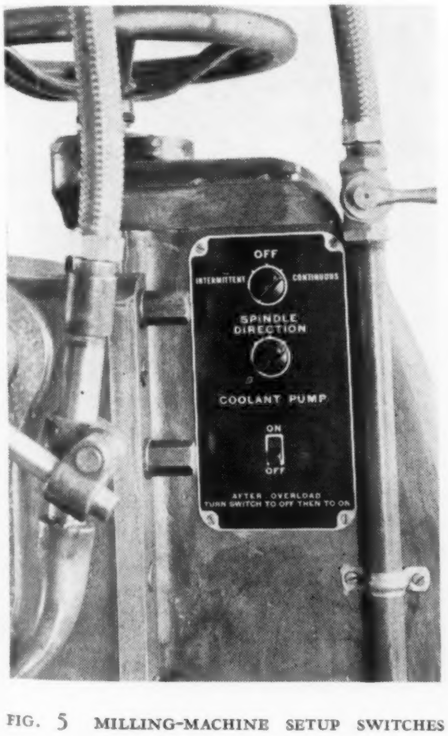


FIG. 5 MILLING-MACHINE SETUP SWITCHES AND COOLANT-PUMP CONTROL

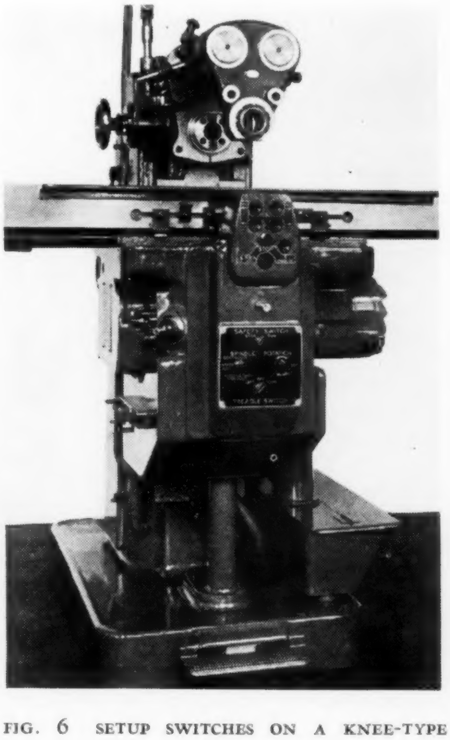


FIG. 6 SETUP SWITCHES ON A KNEE-TYPE MILLING MACHINE

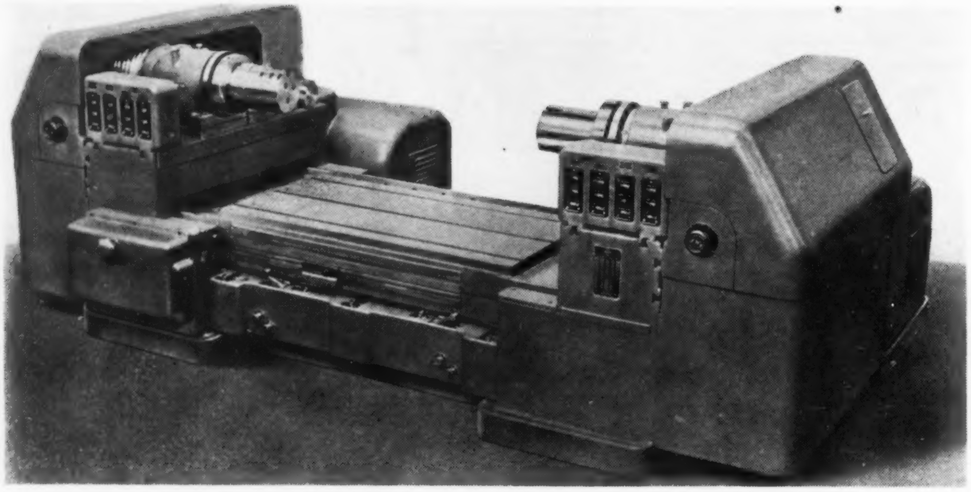


FIG. 8 DUAL-CONTROL STATIONS ON A HEALD BORE-MATIC MACHINE

for another) and running a few more wires between the table and spindle-motor control relays.

(*b*) Coolant flow on a milling machine is usually started and stopped by a selector switch which is snapped off and on by the operator. In a few cases it is desired to have the coolant pump stop whenever the cutter stops. The change is made by transferring the pump leads from the line side to the spindle-motor side of the spindle contactor.

(*c*) A milling-machine spindle head is normally moved manually. It is desired to move the head by power and to have its movement start and stop at given positions in the movement of the table. A special unit can be made up with a motor, reversing contactors, and limit switches to control the head, and then the control can be interlocked with that of the table by adding a few contacts to existing switches and running a few more wires, between relays. Such a unit is shown in Fig. 9.

(*d*) Lower table speeds were desired on an electric grinding machine; by adding a selector switch and a small resistor the speeds were easily obtained.

(*e*) A screw machine is to be equipped with an automatic rod magazine. With an electrically driven and controlled magazine the unit may be readily attached to the machine and long mechanical power take-offs from the machine to the attachment are avoided. It is also possible in such a design to locate the motor right where power is desired (the center of the magazine) and yet have the controls mounted close to the machine, where they can be operated by the machine in its automatic cycle as shown in Fig. 10.

2 PROBLEMS IN DESIGN

Using the Natural Functions of a Motor. In the past, motors have been used almost solely as sources of power. However, motors can be used for starting and stopping, and can easily be reversed. If then a motor were to be employed in a mechanism, the design could well be laid out to use these possible motor functions. Instead of including a clutch in the mechanism to start and stop the unit, the motor may be started and stopped; milling machines are now designed with a direct-connected motor to start and stop the spindle mechanism.

The spindle drives of milling machines have always included an idler gear, shaft, and gear-shift lever to give a reverse direction of rotation. With a unit drive a simple manual reversing switch may be adopted to provide reverse motion.

The direction of table movement in machines is usually changed with a reversing clutch. A motor-drive design can eliminate the reversing clutch and turn this function over to the motor. Reversal of small motors is fast and smooth.

Two-Speed Motors. In some mechanisms the two-speed possibilities of two four-pole a-c motors are helpful. On a milling machine, a two-speed motor can be used for the feed, thus making it possible to halve or double the feed rate of the table. For work of variable width or depth, or for a finish-cut which follows a roughing cut, a change in table feed obtained through the action of a table dog aids the machine in cutting at the most suitable feed rate. An interesting use of two four-pole motors is shown in Fig. 11. This Leland-Gifford drilling machine is equipped with direct-connected motors, which can be operated on 60-, 90-, and 150-cycle circuits. A machine wired for all three frequencies thus has six possible speeds available for each spindle.

Built-In Motors and Controls. In using a motor, a designer should consider building it into his design. By doing so he can probably improve the appearance of his machine and obtain less broken contours. The motor can be better protected, the bearings can be lubricated automatically as part of the driving mechanism, the motor rotor can be mounted on one of the machine shafts, and an efficient drive can be obtained in which belts and couplings may be eliminated. Since the machine bed acts as an excellent sink for heat it is also true that a built-in motor can run at lower temperatures under a given load or can run

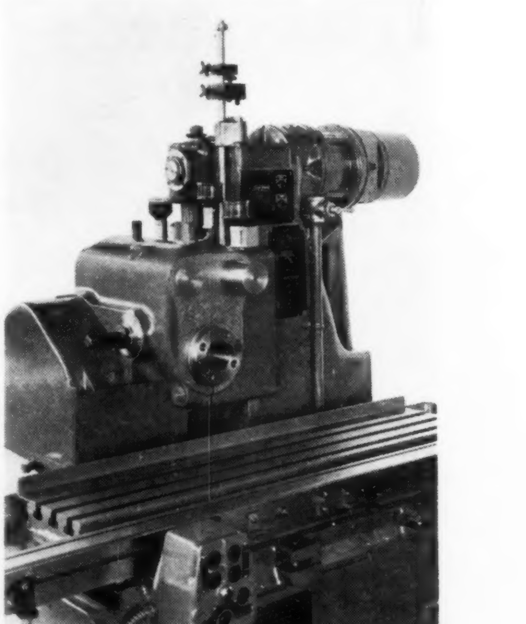


FIG. 9 ATTACHMENT FOR AUTOMATIC MOVEMENT OF A MILLING-MACHINE SPINDLE HEAD

at higher loads without exceeding a safe temperature. In our own shop we were surprised to discover how many 4- and 5-hp cuts were being taken on machines which had 3-hp built-in motors.

When a machine is designed for electrical equipment it is also possible to plan for built-in controls and push-button stations. These should be located where they are easily accessible and must be well protected from oil and coolant. The appearance of a machine is very much dependent on whether controls are built-in or are hung on the outer walls of the machine. Fig. 12 shows a well-planned control panel on a rack-cutting machine designed by the Fellows Gear Shaper Company.

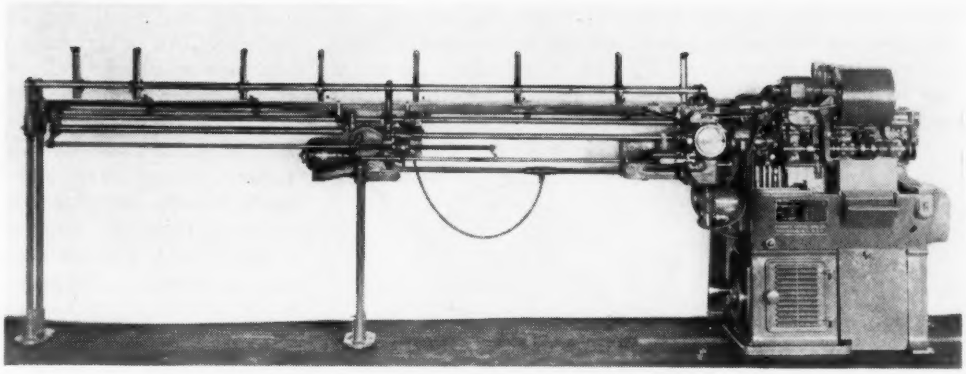


FIG. 10 ROD MAGAZINE ATTACHMENT FOR AN AUTOMATIC SCREW MACHINE

In using electric controls it is very convenient to use prepared harnesses. These are groups of wires which have been cut to proper lengths, equipped with terminals and identifying tags, and bound together. By using these harnesses individual wires do not have to be drawn through the machine and the time required for machine wiring is reduced.

Motor Relations. One of the practical problems in using individual motor drives is in getting motors to operate with a given relation to each other. If the spindle or cutter of a milling machine stops before the table feed stops, then a very great pressure will be set up between the cutter and work, and there will be danger of cracking the cutter. With a single motor driving both the feed and speed cases, there is no possible chance of such cutter breakage, because the feed must slow down and stop with the speed. With separate unit drives for the speed and feed, some step must be taken to make certain that the feed will stop as soon as or before the spindle. In some milling machines the feed motor is plugged to rest or to the point where it actually makes a turn in the reverse direction while the spindle motor is slowing down. By properly selecting motors and the masses of driven parts, the feed motor has been made to stop faster than the spindle and even when the cutter is under heavy cut the cutter cannot come to rest before the table has stopped.

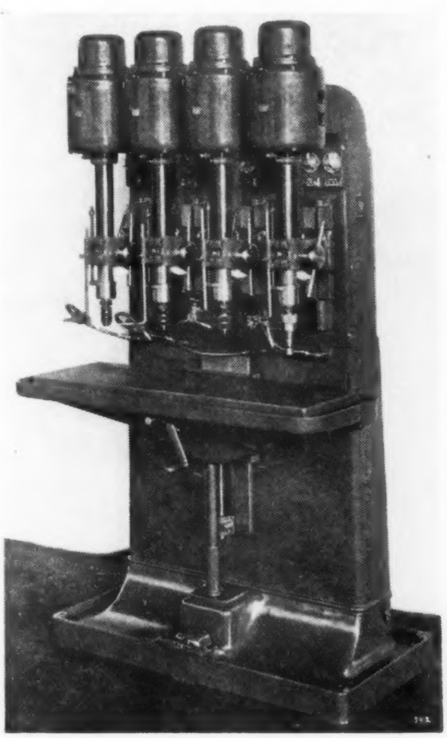


FIG. 11 THREE-CYCLE SIX-SPEED MOTORS ON A DRILLING MACHINE

3 SPECIFIC MACHINES

Thus far this paper has spoken of machine cycles and functions which could be obtained without much reference to how they actually are obtained in present designs. A brief description of two machines may be helpful.

Plain Milling Machine. A milling machine employs separate a-c induction motors of the shell type to drive the spindle and the table. Whenever the spindle is stopped, the power line to the motor is reversed and the motor is plugged to a low speed (3600 to 300 rpm) and then the power circuit is opened by a viscosity switch, such as shown in Fig. 13. As soon as the power circuit is opened a solenoid releases a mechanical brake which brings the motor to rest and holds it there. With such a design there is very little brake wear, because over 95 per cent of the kinetic energy of the rotor- and spindle-drive mechanism is absorbed during plugging.

Direction of table motion is changed by reversing the feed motor. The table is stopped by plugging the feed motor to rest or to the point where it has actually made a turn in the reverse direction. The change from feed to fast travel is obtained by shifting a jaw clutch from a slow-speed to a high-speed driving member. A solenoid supplies the shifting force.

As a cutter completes a blind cut, it is desired to reverse the table and to drop into fast travel for the return to the loading position. If the shift to fast travel occurs before the motor has reversed, a disastrous jump ahead into the work will result. To prevent this improper sequence of operation a viscosity switch is used; this switch is of the directional type and keeps certain circuits open and others closed while the motor is running. With such a switch, the fast-travel clutch cannot be engaged until the feed motor actually reverses and makes a few turns in the desired direction. This same viscosity switch also opens the motor circuit when plugging has brought the motor to rest.

For simplicity of construction and quietness of operation (no reduction gearing) it was desirable to mount the viscosity switch on the motor shaft and to operate at 3600 rpm. No standard switches were available so units similar to the one shown in Fig. 13 were designed. A 0.002-in. film of oil pulls

the outer hollow cylinder in the direction of shaft rotation. Movement of the outer disk opens and closes directional circuits.

A two-speed motor drives the feed. Table dogs tip a mercury switch to change speed from one value to the other. With such control the table can change its feed rate at any point in

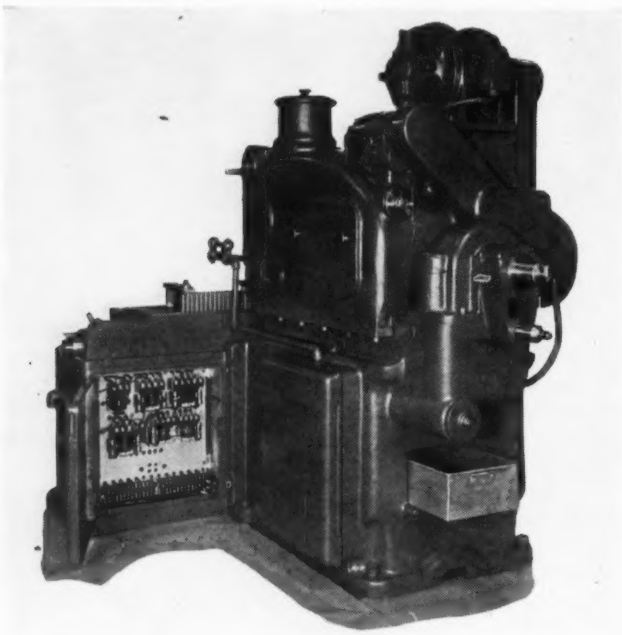


FIG. 12 BUILT-IN CONTROLS ON A FELLOWS RACK SHAPER

the table cycle. Fast travel movement is always at the high motor-speed rate.

Plain Grinding Machine. A plain grinding machine uses seven separate motors and two generators. Five of these are constant-speed motors and may operate on either alternating or direct current. A motor mounted on the wheel slide drives the grinding wheel. The coolant pump is motor-driven as is the lubricating pump. Power for the rapid wheel-slide movement is furnished by a motor mounted on the quick-return case.

To obtain variable speeds, it is necessary to adopt direct current and so the fifth motor is used to drive two direct-current generators. One generator is a constant-potential machine and supplies current to the armature and field of the headstock motor, to the field of the table motor and table-motor generator, and to the control devices. The speed of the headstock motor may be varied through a 4-to-1 range by a rheostat which controls the field of the motor. When the input circuit to the headstock motor is opened, a resistance is placed across the armature terminals to rapidly brake the headstock to a stop.

The table motor has its armature connected to the second generator, which is a variable-voltage machine. A rheostat in the field circuit of the generator permits the output potential to be varied. Reversal of the generator field changes the polarity of the voltage. The table motor with its constant field and variable armature voltage can operate anywhere in a 4-to-1 speed range in the high-gear series, and anywhere in an 8-to-1 range in the low-gear series. When the motor-armature current is reversed the motor reverses; thus, changes in motor speed and reversal of the motor are obtained by changing or reversing the field of the table generator. To get a smooth and accurate reversal, the table is always slowed down just before it trips the limit switch which starts reversal. Dwell at the position of table reversal is obtained by using magnetic timing relays.

CONCLUSION

This paper has covered a rather wide field and of necessity has been incomplete in its treatment of many subjects. It should, however, serve to portray what is being done in the electrification of machine tools and should suggest some of the fundamental advantages which are stimulating the use of electric motors and controls. Electric-design developments have been rapid during the last five years, but we expect the pace to be quickened in the next five years. Manufacturers of electrical equipment are cooperating with machine-tool builders and are working to improve their devices and to better adapt them to machine tools. Already control designs have changed from large bulky units, which were to be mounted on the walls of the room and operated occasionally, to the small compact devices which can be mounted in a machine and operated almost continuously. With the help of the electrical manufacturers the progress along the lines that have been reported in this paper can be continued and accelerated.

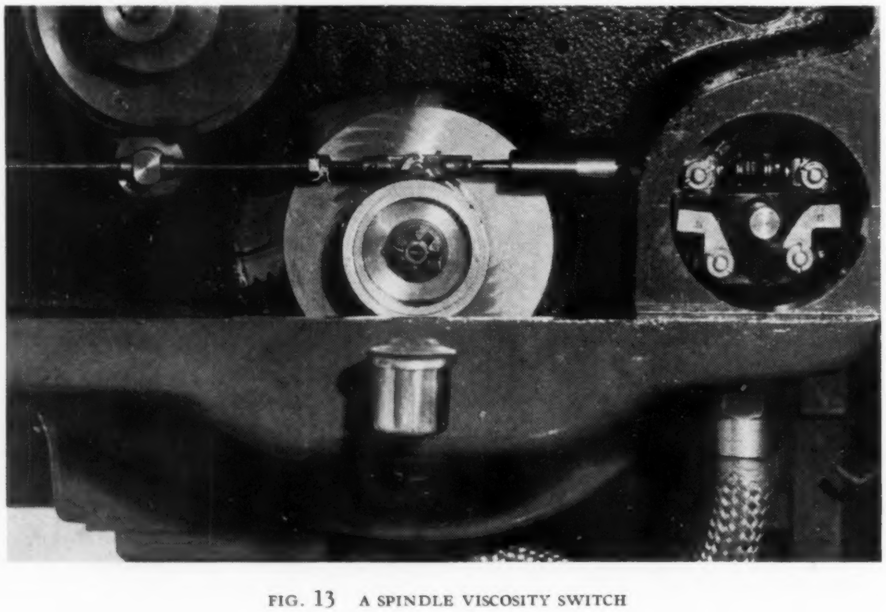


FIG. 13 A SPINDLE VISCOSITY SWITCH

SYNTHETIC SUBSTANCES *With* RUBBER-LIKE PROPERTIES

By E. R. BRIDGWATER

E. I. du PONT de NEMOURS & CO., WILMINGTON, DEL.

Although synthetic products having some of the properties of rubber have been known for many years, their large-scale commercial development dates only from the beginning of the current decade. Today, a great profusion of more or less rubber-like synthetic products is available to the engineering profession—a profusion that must be confusing to engineers who have not had an opportunity or occasion to make a careful survey of the field. The confusion is heightened by the tendency of many who are engaged in promoting products or ideas to draw broad generalizations in terms that are devoid of exact meaning.

Engineers who pride themselves on their accuracy of thought and expression may state that "synthetic rubber is more oil-resistant than natural rubber" failing to recognize the statement as meaningless because (*a*) the term "synthetic rubber" is used in a loose and inaccurate sense and no one knows how broad its connotation may be and (*b*) the term "oil resistance" is equally indefinite. In order to promote clear thinking, let us first consider the meaning of the terms "synthetic rubber" and "rubber-like properties."

Strictly speaking, there is no commercial product that can be called synthetic rubber because, if we follow the accepted usage of the past, synthetic rubber would be a product substantially identical with natural rubber in chemical structure and physical properties. For example, synthetic camphor is so called because it is camphor and differs from natural camphor only in that it is made by a synthetic process rather than by extraction from a tree. The principal uses for camphor are for plasticizing pyroxylin and as a medicament for the relief of common colds. A new plasticizer for pyroxylin or medicinal agent for the relief of colds may be discovered which resembles camphor in some respects but has certain properties which appear to make it superior for one of these uses. But such a new product would hardly be called synthetic camphor.

The statement "synthetic substances with rubber-like properties" might be defined to include only substances that resemble rubber in all its important properties, but such a definition would exclude certain products which resemble rubber at least in extensibility, and are of commercial importance. We shall therefore consider the term to mean substances that resemble rubber in the single property of extensibility or deformability under moderate loads, coupled with a tendency to recover their original form when the load is removed, although not necessarily to a degree comparable to the recovery exhibited by natural rubber.

Synthetic products that are rubber-like in this broad sense fall into two broad groups: (*a*) Those that resemble rubber in chemical structure and (*b*) those that do not. The chemistry of the first group has been admirably presented by Whitby (1)[1] and Katz. Summarizing briefly, rubber is a polymer of beta-methyl-butadiene (Isoprene)

$$\begin{array}{ccccccc} \mathrm{H} & & & & \mathrm{H} & & \mathrm{H} \\ \mathrm{HC} & = & \mathrm{C} & - & \mathrm{C} & = & \mathrm{CH} \\ & & | & & & & \\ & & \mathrm{CH_3} & & & & \end{array}$$

If the methyl group CH_3 is replaced by a hydrogen atom H, we have butadiene. If it is replaced by a chlorine atom Cl, chloroprene results. Polymerized butadiene, with or without the addition of modifying agents, is made in Germany and is known to the trade as Buna rubber or Perbunan. Polymerized chloroprene is made in the United States and is known generically as neoprene. Vulcanized neoprene products are also sold under a hundred or more trade names, each identifying the product of a certain manufacturer, but usually failing to identify it as neoprene. These materials, polymerized butadiene and polymerized chloroprene, resemble rubber quite closely, as might be expected from the fact that their progenitors possess the same chemical structure as isoprene, although in each case a substitution has been made in one of the chemical building blocks. Like rubber, they are vulcanizable, that is, when heated under proper conditions they become much less plastic, more elastic, and less susceptible to changes in properties with changes in temperature. After vulcanization they cannot be remolded to another shape because of their loss of plasticity.

The other group of rubber-like synthetics consists of products whose chemical structure bears no resemblance to that of rubber, but which, nevertheless, share some of its properties. In this group are (*a*) the plastic glyptal resins (2), condensation products of a polybasic acid, such as phthalic or adipic, with a polyhydric alcohol, such as glycerin or ethylene glycol, (*b*) the alkylene sulphides (3, 4), made by condensing ethylene dichloride or other dihalides with an alkaline polysulphide, such as are sold under the trade name "Thiokol," (*c*) polyvinyl alcohol (5), and (*d*) plasticized polyvinyl resins (6) such as are sold under the trade name "Koroseal." These products, and many other plastics which have never outgrown the test-tube stage, have the rubber-like property of extensibility or deformability under relatively light loads. Certain of these products, especially the alkylene polysulphides, are vulcanizable in a limited sense of the word, that is, they become less plastic and more elastic when heated, although after vulcanization they are still definitely thermoplastic and, under proper conditions, capable of being remolded to other forms. Others, such as the plasticized polyvinyl resins, are definitely nonvulcanizable and can be hot-molded and remolded without altering their properties.

PHYSICAL PROPERTIES

The properties of vulcanized products derived from polychloroprene (7, 8, 9, 10) and polymerized butadiene (11) have been described in numerous articles and pamphlets published or inspired by the manufacturers of those products. Likewise,

Contributed by the Process Industries Division for presentation at the Fall Meeting, Providence, R. I., October 5–7, 1938, of The American Society of Mechanical Engineers.

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

the properties of certain compositions derived from the alkylene polysulphides (12, 13), from the plasticized polyvinyl resins (14, 15), and from the glyptal resins (2) have been made available by the manufacturers for the benefit of prospective consumers.

It is difficult to compare the properties of the vulcanizable polymers of butadiene and of chloroprene with those of rubber because the vulcanized products made from them have a very wide range of properties, which properties depend upon the kind and amount of other ingredients that are mixed with them and conditions of vulcanization. This difficulty becomes an impossibility when we broaden the field to include the thermoplastic rubber-like materials which are comparable with rubber and with the vulcanizable synthetics only over a narrow temperature range and with respect to only a limited number of physical properties. Although any attempt at direct comparison of these materials would be misleading, it should be helpful to consider methods of evaluation and the significance of some of the terms which are commonly used in reporting their properties.

Oil Resistance. By oil resistance we mean the degree to which a material retains its useful properties and serviceability in the presence of oils. The most obvious, but seldom the most important, change that occurs when rubber or a rubber-like material is immersed in an oil is the change in volume. Scott (16) showed that the swelling which is characteristic of rubber may be divided into two separate phases (*a*) the initial swelling which proceeds rapidly in a few hours or days to such a point that the rubber is incapable of immediately imbibing any more of the particular solvent at the temperature of test, and (*b*) the slower continued increase in volume which represents deterioration of the rubber by the solvent. The initial swelling as measured by a test extended over a period of a month or less has sometimes been taken as a measure of oil resistance. This may be very misleading because the change in physical properties that have to do with the serviceability of the product is not necessarily proportional to change in volume (17). For example, chloroprene rubber can be compounded so as to undergo no change at all in dimensions in any given oil at any specified temperature, but such a nonswelling compound is frequently not the most serviceable one that could be produced.

The second phase of the swelling is of great importance because it enables one to establish a trend from which the condition of the product after several years' contact with oil can be roughly forecast. Although important deductions may be drawn from the curve representing change of volume with time, and especially the trend of the curve after a temporary equilibrium has been reached between the rubber-like material and the solvent, it is nevertheless true that the only reliable way to determine the oil resistance of a rubber-like synthetic is to give it a long-time test under conditions comparable to those that may be encountered in service including flexing, compression, or other mechanical factors that may be involved, and heat, where it is a factor.

Short-time tests are especially unreliable as a means of forecasting the resistance of rubber or rubber-like products to hydrocarbons which contain small amounts of nonhydrocarbon impurities, or materials that are added in small amounts for a specific purpose. Slight modifications of the constitution of the oil or solvent seldom affect the first phase of swelling but may profoundly affect the second phase, that is, they may cause progressive deterioration of the rubber or rubber-like material which would not be forecast from a brief swelling test.

One is frequently concerned not only with the effect of an oil or solvent on a rubber-like material, but also with the effect of the rubber-like material on oil. For example, plasticized polyvinyl resins or compositions derived from polymerized chloroprene or butadiene may decrease in volume if they contain an excessive amount of plasticizers due to extraction of the plasticizer or softener by the oil. The decrease in volume may or may not be objectionable in itself, but the contamination of the oil is quite likely to be objectionable. Such contamination as occurs is usually due to added compounding ingredients rather than to the base material itself.

Sunlight Resistance. The deterioration of rubber in sunlight is believed to be due primarily to surface ozonization. Most of the rubber-like synthetics are more resistant to this type of deterioration than is natural rubber, and some of them may be compounded so as to be practically immune to this type of failure. The degree of difference in the resistance of the various synthetics is dependent upon the type of compounding ingredients used and the conditions of exposure, that is, whether or not the rubber-like product is under tension or is subjected to flexing or abrasion. Attempts have been made to evaluate sun-checking resistance in the laboratory by the use of a Fade-O-Meter or a similar intense source of artificial radiation, but it is generally conceded that the only reliable evaluation is a service test.

Abrasion Resistance. It is impossible to speak of the abrasion resistance of rubber or any synthetic material without defining the exact type of compound under consideration and the type of abrasive condition that is to be met. Each of these synthetic products has been found to have abrasion resistance equal to or superior to that of rubber under conditions favorable to that particular product. However, it would be foolhardy to state that any synthetic product is equally or more abrasion-resistant than rubber under all conditions of service. As a matter of fact, it is impossible even to state broadly that one rubber compound is more abrasion-resistant than another. Pure gum rubber makes a more durable lining for sandblast hose than the type of compound used for tire treads, however, pure gum rubber would make a very poor tire tread indeed. With respect to the thermoplastic products, it should be borne in mind that the heat generated during abrasion may be an important factor. The manufacturers of rubber-like synthetics are generally aware of the conditions under which their products show best results and can tell a prospective user what results may be expected under any given set of conditions. The final answer is, of course, a service test on a composition designed for the particular job at hand.

Elasticity. By elasticity we mean not extensibility, but rather the ability of the material to regain its original form after removal of a force which has caused distortion. The rate and degree to which the product returns to its original dimensions are a function not only of the degree of distortion but of time and temperature. Generally speaking, the polymers of butadiene and of chloroprene have elasticity comparable to that of natural rubber. They may be either superior or inferior depending upon the kind and amount of compounding ingredients used and the conditions of test. The plasticized polyvinyl resins are quite elastic at low temperatures but, of course, suffer plastic flow at elevated temperatures. The alkylene polysulphides have elasticity comparable to that of rubber when measured under conditions of test that involve only momentary impact, such as the bounce of a ball. However, when distorted by a load that is applied over a period of time they show considerable plastic flow. This is especially true when the test is conducted at elevated temperatures.

Chemical Resistance. The rubber-like synthetics are generally more resistant to oxidation and to the destructive action of chemicals than is natural rubber. Obviously, however, both

the chemical resistance and oxidation resistance depend to a great extent upon the nature of the added compounding ingredients and the conditions of vulcanization (for those that are vulcanizable). Moreover, all of these products have their weak points. The alkylene polysulphides are attacked by alkalies; certain modified butadiene rubbers are attacked by polar compounds; and chloroprene rubber and the synthetics in general with the sole exception of the plasticized polyvinyl resins are vigorously attacked by strong oxidizing acids such as chromic. The manufacturers of these products are generally able to provide information as to their suitability for use in connection with any given chemical.

Heat Resistance. There is no rubber-like material that is not affected to some extent by even moderate degrees of heat, such, for example, as 100 C. Some of the butadiene polymers and the chloroprene polymers can be compounded to have greater resistance to heat than the best heat-resistant natural-rubber compounds, but it does not follow that any compound derived from polymerized butadiene or polychloroprene will have greater heat resistance than any rubber compound. Heat resistance is, of course, an indefinite term that requires definition before exact statements can be made regarding it. It is impossible to set the maximum temperature that any compound derived from rubber or a rubber-like synthetic will withstand without specifying the time of exposure, the conditions—whether exposed to air or to oils or to neither—and the degree and type of deterioration that may be tolerated before the product becomes unserviceable.

SPECIFICATIONS AND TESTING METHODS

It has previously been emphasized that a service test is the only test which will definitely determine the relative serviceability of rubber and the various rubber-like synthetics for any purpose and, where a service test is impractical, laboratory tests should be designed to simulate as closely as possible the conditions of service. It is frequently necessary to provide some means of accelerating tests in order to get the answer in a reasonable length of time. Great care must be exercised in devising accelerated tests that will really be comparable to a longer test under conditions more closely approaching those encountered in actual use.

Certain rubber products that are used in substantial quantities for industrial purposes are purchased to specification. Frequently, such specifications call for a product having a certain minimum tensile strength, ultimate elongation, cold flow, or other readily determinable physical properties. One should not lose sight of the fact that the properties of the rubber that are made the basis of the specification are frequently properties that come into play to a minor extent, if at all, in actual service. For example, rubber is seldom used under loads which even approach its ultimate tensile strength, hence, the only excuse for specifying tensile strength is that there may be some relationship between the tensile strength of a rubber composition and the less readily determinable physical properties which are directly related to the serviceability of the finished product.

This assumption is frequently contrary to fact as applied to rubber goods, but there is even less basis for assuming that because a type of natural rubber or chloroprene rubber having a certain tensile strength has been found to do a certain job satisfactorily any other synthetic or natural product would be inferior if it failed to display that same tensile strength. Generally speaking, the conventional tests used in specifications are grossly inadequate as a measure of the serviceability of some new product that may be offered to do a certain job but may be valuable as a means of checking the uniformity of succeeding deliveries of a product which has been completely evaluated by adequate performance tests.

CONCLUSION

It has been pointed out that the products included in the broad terms "synthetic rubbers" and "synthetic rubber-like materials" have little in common except the ability to stretch to several times their initial length before breaking. In fact, there is less similarity between some of these synthetic products and others than there is between some of them and natural rubber. Moreover, the properties of some of these synthetic products may be varied over such a wide range by compounding with other ingredients and vulcanizing under varying conditions that it is unsafe to generalize about any of them. The difficulty of drawing valid generalizations is further complicated by the fact that such terms as "oil resistance," "abrasion resistance," and "heat resistance" are devoid of exact meaning, and, if valid conclusions are to be drawn regarding these or any other physical properties, the methods of measuring those properties must be exactly defined.

The only way to ascertain whether a rubber-like synthetic product will be suitable for a specific use is to analyze the conditions of service, prepare a composition whose properties approach as closely as possible the ideal revealed by that analysis, and test that composition under conditions related as closely as possible to those that may be encountered in service. It will probably never be possible to tabulate the properties of rubber-like synthetics in so comprehensive a manner that the engineer will be able to select the right product for any particular use by consulting a handbook. Today, at least, it is true that any general tables of properties that may be prepared would be so misleading as to do more harm than good. The engineer who would use rubber or rubber-like synthetics wisely must accept these facts and work within the limitations imposed by them.

BIBLIOGRAPHY

1 "Synthetic Rubber," by G. S. Whitby and M. Katz, *Industrial and Engineering Chemistry*, vol. 25, 1933, p. 1204.

2 "Alkyd Resins Developed Into New Forms," by J. G. E. Wright, *Chemical and Metallurgical Engineering*, vol. 39, 1932, p. 438.

3 U. S. patent 1,890,191, granted to J. C. Patrick.

4 "The Formation of High Polymers by Condensation Between Metallic Polysulphides and Dihalogenated Hydrocarbons and Ethers," by J. C. Patrick, Transactions of the Faraday Society, vol. 32, 1936, p. 347.

5 U. S. patent 1,672,156.

6 U. S. patent 1,929,453, granted to W. L. Semon.

7 "Effect of Oils and Chemicals on Duprene Compounds," by O. M. Hayden and E. H. Krismann, *Industrial and Engineering Chemistry*, vol. 25, 1933, p. 1219.

8 "Physical Properties of Duprene Compounds," by E. R. Bridgwater, *Industrial and Engineering Chemistry*, vol. 26, 1934, p. 33.

9 "The Neoprene Handbook," E. I. du Pont de Nemours & Company, Inc., Wilmington, Del.

10 "The Neoprene Notebook," E. I. du Pont de Nemours & Company, Inc., Wilmington, Del.

11 "Perbunan," Advance Solvents & Chemical Corp., N. Y. C.

12 "Thiokol Facts," The Thiokol Corp., Trenton, N. J.

13 "Constitutions of Polysulphide Rubbers," by S. M. Martin and J. C. Patrick, *Industrial and Engineering Chemistry*, vol. 28, 1936, p. 1145.

14 "Koroseal—A New Plastic," by S. L. Brous and W. L. Semon, *Industrial and Engineering Chemistry*, vol. 27, 1935, p. 667.

15 "Koroseal," The B. F. Goodrich Company, Akron, Ohio.

16 "The Swelling of Vulcanized Rubber in Liquids," by J. R. Scott, Transactions of the Institution of Rubber Industries, vol. 5, 1929, p. 95.

17 "The Testing of Rubber and Rubber-Like Materials for Oil Resistance," by O. M. Hayden, Proceedings of the American Society for Testing Materials, vol. 54, part 2, 1934, pp. 635–646.

INDUSTRIAL-EVAPORATOR
Design, Application, and Operation

By W. K. ADKINS

FIRESTONE TIRE & RUBBER CO., AKRON OHIO

THIS PAPER on industrial-evaporator application deals primarily with the reasons why evaporators were chosen for the high-pressure power plant at the Firestone Tire & Rubber Company, Akron, Ohio, and mentions briefly the operating problems which have been encountered to date.

In industrial plants which require both steam and power for their various processes, and where those requirements are in the proper ratio, large economies can be effected by the installation of high-pressure boilers, and bleeder or back-pressure turbines. There is no set rule by which the proper pressure can be determined, because each installation will depend upon local conditions and requirements. The water supply, the pressure, and quality of the process steam determine, to a large extent, the selection of equipment.

Studies for the Firestone installation indicated that the largest returns on the investment could be obtained from a boiler having a pressure of around 900 lb per sq in. provided the turbine exhausted directly into the process-steam main; whereas, if the turbine were exhausted into an evaporator system the optimum boiler pressure would necessarily be around 1300 lb per sq in. All calculations were based upon a maximum steam temperature of 750 F.

The evaporator installation and boiler designed for a pressure of 1400 lb per sq in. were decided upon in the case which is under consideration for the following five reasons:

1 The raw-water supply contained a maximum total solids of 30 grains per gal, 20 grains of which were sodium chloride.

2 A large percentage of the condensate from the process steam could not be returned to the boiler because part of it was contaminated and part of it was required for other purposes. These conditions would have necessitated approximately 80 per cent make-up.

3 At the time of this installation the experience on treating water for boilers in the pressure range of 800 to 1400 lb per sq in. was very limited. Even though the water could have been successfully treated, it was realized that excessive blowdown would still have been necessary.

4 By keeping the water for the high-pressure boiler in a closed system, a much closer control of noncondensing gases can be maintained.

5 The concentration of the boiler water can be kept low; consequently, the possibility of solid carry over from the boiler to the turbine is minimized. Operating experience with this equipment has indicated that the latter reason alone is sufficient to justify the installation of evaporators in plants having a water supply such as described herein.

Contributed by the Power Division for presentation at the Fall Meeting, Providence R. I., October 5–7, 1938, of The American Society of Mechanical Engineers.

HEAT BALANCE

From the heat-balance diagram, shown in Fig. 1, it will be seen that the turbine exhaust flows through the evaporator system parallel with an evaporator feedwater heater. The condensate from this equipment is collected in a common header and returned to a surge tank, which also receives the system make-up water. From the surge tank the water flows through a drip cooler for the purpose of increasing the net positive suction head on the boiler feed pumps, which provides protection from flashing. It will be observed that the only possible points where oxygen can enter the high-pressure system is with the condensed-steam make-up or through heat-exchanger leakage, since the entire system is always under pressure. This arrangement minimizes oxygen corrosion problems and is an additional reason for an evaporator installation.

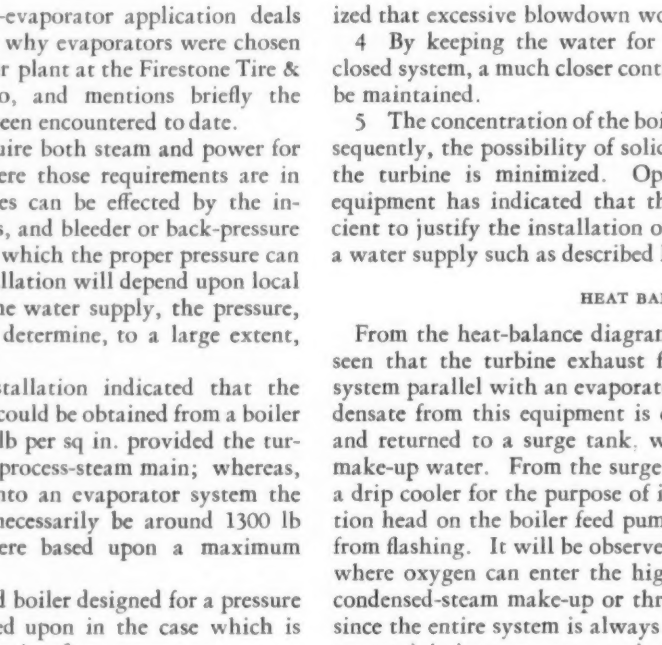


FIG. 1 HEAT-BALANCE DIAGRAM ON THE FIRESTONE HIGH-PRESSURE POWER PLANT

Under full-load conditions the turbine-exhaust pressure ranges from 235 to 250 lb per sq in. gage, and the temperature from 400 to 430 F. With a vapor pressure of 180 lb per sq in. in the evaporator shells, a pressure differential of 55 to 60 lb per sq in., or a heat head of approximately 22 F, is provided.

When supplied with 300,000 lb per hr of turbine exhaust, the evaporator system will produce 255,000 to 260,000 lb of vapor per hr at a pressure of 180 lb per sq in., depending upon the exhaust-steam temperature and the amount of blowdown required for concentration control. This performance is based on feedwater having a temperature of 375 F and containing impurities of not more than 22

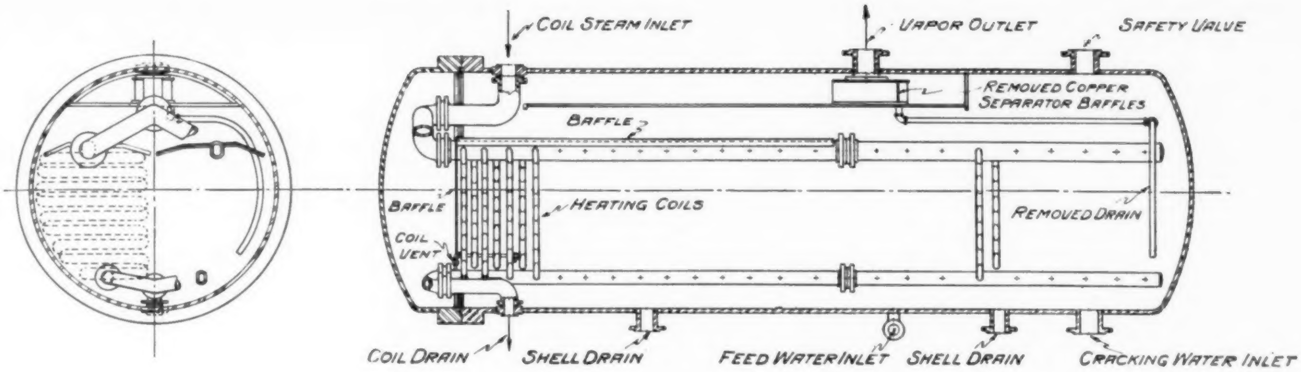


FIG. 2 DETAILS OF ONE OF THE EVAPORATORS

grains per gal and a maximum concentration in the shell not exceeding 250 grains per gal. The evaporator feed heater is designed to condense 10 to 12 per cent of the turbine exhaust, which, when the tubes are clean, will raise the feedwater temperature approximately 100 F, or to within 6 F of the evaporator brine temperature.

EVAPORATOR TEST DATA

Each of the five evaporators contains 4320 sq ft of effective coil surface made up of 16 Bwg arsenical copper tubes. These evaporators were designed for an operating heat transfer of 475 Btu per sq ft per hr per deg F temperature difference, and from 640 to 680 Btu with perfectly clean tubes. From the following tests, which were conducted after three years of operation, it will be seen from the present heat-transfer rate that the evaporator coils have remained free from scale deposit. The tests were conducted with the continuous-blowdown valves closed. It was also necessary to carry a higher vapor pressure during this period; hence, the test data will not be in exact agreement with the values shown on the heat-balance diagram in Fig. 1.

SCALE DEPOSIT IN HEAT EXCHANGERS

Considerable difficulty has been experienced with scale formation in the feedwater heater because of its relatively high operating temperature. A number of chemicals have been used to prevent scale deposit in this exchanger, none of which has been entirely satisfactory. Shortly after the unit was placed in operation it was found necessary to install a by-pass around the feedwater heater so that it could be cleaned during operation. The heat transfer in the evaporator coils now, under normal conditions, is such that full load can be handled with the feedwater heater cut out of the system. This is possible because of the fact that the evaporator feedwater is conditioned to prevent scale formation, rather than to use raw water and depend upon cracking for scale removal.

Some scale is formed in the evaporator drip cooler and make-up condenser, which necessitates periodical mechanical cleaning. During the summer months, the cleaning periods are as long as three months apart, however, more frequent cleanings are required during cold weather, the reason being that with cold water the chemical reactions in the softening plant are not as complete as they are when warm water is used.

FEEDWATER CONDITIONING

The evaporator feedwater is treated in a cold-process batch softener using lime, soda ash, sodium aluminate, and ferric sulphate. It is then heated to a temperature of 220 to 225 F in a deaerating heater. After the heater, a tannin compound is added before the water enters the heat-exchanger system. Before using the tannin compound it was frequently necessary to clean the evaporator drip cooler and make-up condenser every week. Now, as stated previously, it is necessary to clean them only approximately every three months during warm weather and every six to eight weeks during cold weather. The final water conditioning takes place in the evaporator shells where phosphate is delivered direct to maintain an excess of 30 to 50 ppm. With this method of water conditioning, it is necessary to crack the evaporators only four to six times a year to remove a very thin eggshell-like deposit.

The representative water analyses in Table 1, which were made recently, may be of interest. Continuous blowdown is used to control the concentration of the evaporator brine.

TABLE 1 REPRESENTATIVE ANALYSES OF EVAPORATOR FEEDWATER AND CONCENTRATE

	Evaporator feedwater	Evaporator concentrate
NaOH, ppm	13.7	253
Na_2CO_3, ppm	38.0	109
Na_2SO_4, ppm	171.0	1490
NaCl, ppm	132.0	1150
$CaCO_3$, ppm	5.1	...
Na_3PO_4, ppm	...	83
Silica, ppm	9.9	50
Alumina, ppm	1.8	10
Oil	...	Trace
Total solids, ppm	344.0	...
Total dissolved solids, ppm	...	3360

STEAM QUALITY

Fig. 2 shows the section and end view of one of the evaporators. To provide for moisture elimination, a vertical baffle was installed at the head end, running from the bottom of the shell to a point near the top of the tube bundle, where it joins a horizontal baffle which extends halfway to the rear head and lies about 12 in. above the water surface. Above the first baffle, a second horizontal baffle is installed from a point near the front head, extending to the rear, beyond the vapor outlet, where it is closed off. The final vapor separator consists of several rows of vertical V-shaped baffles through which the vapor is passed before leaving the evaporator shells. This gill-type separator is drained into a false bottom, details of which are shown in Fig. 3, and a 2-in. submerged drain was originally installed, terminating near the bottom of the evaporators. During the early stages of operation, considerable difficulty was experienced with moisture in the vapor. A number of tests showed the quality of the vapor to be 90 to 93 per cent. The pressure drop through the last-stage separator also caused trouble. At full load, a maximum differential of 30 lb per sq in.

between the shell and vapor main was noted. It was found, upon examination, that the vertical baffles in the last-stage separator were badly distorted and they were removed. This step reduced the pressure drop to normal and reduced the moisture content in the vapor slightly. The internal drainpipe was next removed, which resulted in a remarkable improvement,

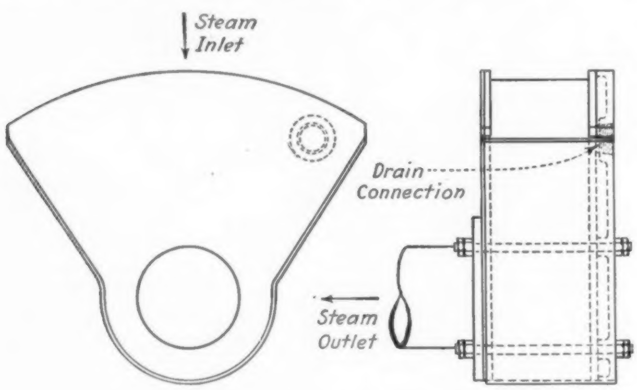


FIG. 3 DETAILS OF LAST-STAGE SEPARATOR

and brought the vapor quality up to an average of 99.6 per cent, as will be seen from the test data in Table 2.

EVAPORATOR-COIL DETERIORATION

Two evaporator coils have failed since the equipment was placed in operation in January, 1935. Thorough examination of the failures indicated the inclusion of slag. So far as it has been possible to make an examination, no external tube deterioration has been discovered. Some internal deterioration, however, has been indicated by the presence of copper oxide in the boiler. Several tubes were removed from the evaporators after 15 months of operation and cut into sections. Micrometer measurements showed full gage, or better, on all samples, and only a very small loss in weight was found. However, when they were examined under a microscope they appeared to have a large number of very minute pits on the inside surface, which were in the form of pinholes and evenly distributed. This deterioration is probably due to the low pH value of the steam. It is the consensus of opinion that the present rate of tube deterioration is not sufficient to be a cause for alarm.

In conclusion, it is believed that evaporators have a very definite place in industrial installations, particularly, where high-pressure installations are used to produce both power and steam and the feedwater contains a large amount of impurities. The principal proportions of the evaporators at the Firestone plant, together with their working pressure and temperature, are given in Table 3. Evaporator performance data are given in Table 4.

TABLE 2 EVAPORATOR TEST DATA

	Turbine exhaust flow, lb per hr	Vapor pressure, lb per sq in. Group 1[a]	Group 2[b]	Vapor quality, % Group 1[a]	Group 2[b]
With internal drain...	170000	180	184	93.4	93.2
With internal drain...	300000	180	184	<90.0	<90.0
With internal drain...	299000	...	188	....	93.0
With drain removed...	300000	181	181	99.8	99.4
With drain removed...	300000	180	183	99.6	99.6

[a] Group 1 consists of two evaporators.
[b] Group 2 consists of three evaporators.
NOTE: Both calorimeter tests and analyses of the solids were used in determining carryover.

TABLE 3 EVAPORATOR DATA[a]

Surface:	
Effective coil surface per unit,[b] sq ft	4320
Number of coils per unit	340
Disengaging area per unit, sq ft	260
Working pressure, lb per sq in.	250
Test pressure, lb per sq in.	675
Working temperature, maximum, F	600
Shell:[c]	
Diameter, in.	108
Thickness, in.	$1^1/_4$
Length, ft and in.	$28\text{-}8^1/_2$
Head thickness, in.	$1^5/_8$
Working pressure, lb per sq in.	190
Test pressure, lb per sq in.	285
Working temperature, F	500

[a] Five single-effect evaporators are used in the Firestone plant; they are of all-welded construction, with one integrally formed steel head and one removable flanged steel head.
[b] The tubes are 1 in. outside diameter, and are made of 16 Bwg arsenical copper.
[c] Class 1 shell, A.S.M.E. Code, welded.

TABLE 4 EVAPORATOR PERFORMANCE DATA

1	Test number	1	2
2	Duration of test, hr	1	2
3	Number of evaporators	5	5
4	Average water level above evaporator center line, in.	9	8
5	Average feedwater to evaporator, lb per hr	254000	256000
6	Average steam from high-pressure boiler, lb per hr	295000	297000
7	Average steam to evaporator coils (estimated), lb per hr	291000	257000
8	High-pressure boiler-drum pressure, lb per sq in.	1290	1290
9	Temperature of steam leaving superheater of boiler, F	746	745
10	Average exhaust pressure, back pressure at turbine, lb per sq in.	246	244
11	Average temperature at back-pressure turbine exhaust, F	426	425
12	Average evaporator-coil pressure, lb per sq in.	244	241
13	Corresponding saturated steam temperature, F	404	403
14	Average vapor pressure in main line, lb per sq in.	188	188
15	Average evaporator-shell pressure, lb per sq in.	199	200
16	Corresponding saturated-steam temperature, F	387.4	387.8
17	Corresponding heat in vapor, Btu per lb	1198.6	1198.6
18	Corresponding heat in water entering evaporator, Btu per lb	238.7	348.0
19	Temperature of feedwater entering drip cooler, F	224	224
20	Temperature of feedwater entering make-up condenser, F	259	261
21	Temperature of feedwater entering feed heater, F	270	270
22	Temperature of feedwater entering evaporators, F	270[a]	375
23	Temperature difference, coil to shell (Item 13—Item 16), F	16.6	15.2
24	Temperature difference, coil to shell, with approximate correction for superheat in steam to coils and feedwater temperatures below saturated-steam temperatures, F	24.2	17.0
25	Heat transfer, Btu per sq ft per deg F per hr, using Item 23	680	661
26	Heat transfer, Btu per sq ft per deg F per hr, using Item 24	455	591
27	Total solids in evaporators at start, ppm	1700	2060
28	Total solids in evaporators at end, ppm	1925	2500
29	Average solids in feedwater to evaporators, ppm	173	170
30	pH of vapor ranges from	5.9 to 6.2	
31	Total solids in steam (by conductivity and with no correction for CO_2), ppm	4.5 to 5.1	

[a] Evaporator feedwater heater out of service.

Recent Developments in

THREAD-GRINDING PRACTICE*

By PAUL V. MILLER

TAFT-PEIRCE MANUFACTURING CO., WOONSOCKET, R. I.

FOR MANY years the grinding of threads in this country was confined almost entirely to the cutting-tool and gage industries, since it was deemed unnecessary to attempt a high degree of precision in the manufacture of commercial parts. However, with the general adoption of the various classes of fit recommended by the National Screw Thread Commission, the task of producing threaded parts to class-four fit became increasingly more difficult. In some industries, particularly aircraft and aircraft-engine manufacturing, many threads must be finished to a high degree of accuracy, either by milling or grinding. Shafts and similar parts must be threaded on centers to insure concentricity with other diameters, and here thread grinding is giving the desired degree of accuracy within reasonable limits of time and cost. The grinding of threads is generally admitted to be somewhat more expensive than milling, both from the standpoint of the time involved for the operation and the cost of tools, such as grinding wheels and diamonds for dressing. However, where the tolerances of pitch diameter, pitch, angle, and finish are so close as to make the milling operation particularly difficult, and often expensive because of rejected material, the grinding of the threads is frequently much more satisfactory, and in the final analysis more economical.

During the past 15 years much progress has been made, not only in the design and construction of the machine tools utilized for thread grinding, but in the development of the grinding wheel as well. Many improvements have been effected in the manufacturing of grinding wheels, and it is now almost impossible to detect any appreciable variation in the cutting qualities of wheels made to the same specification, whereas, only a few years ago quite a wide variation might be detected in different wheels received in the same lot. Improvements and developments in the materials used for bonding the grinding wheels have resulted in a much stronger material, and it is now possible to operate the wheels at speeds which are much higher than those used formerly. This increase in speed has resulted in improved cutting qualities and in longer wheel life between dressings.

The type of grinding to be done and the method to be employed in developing the finished threads are just as important as the selection of the machine and its wheels. In fact, the type of work and the ease or difficulty with which it may be handled may have an important bearing on the scheduling of the threading operations. One important question is whether the thread should be ground from the solid, or whether it should be milled before heat-treating or hardening. A number of factors should also be given consideration before a definite decision is made, such as, for example, the quantity, the pitch of the thread, the size and shape of the work, and the probable cost per piece for tools. If the piece is simple and the quantity small, probably the most economical method would be to grind the thread from the solid, including roughing and finishing, before removing the work from the machine. On the other hand, if the quantity is larger, better results would be obtained by rough-grinding as many parts as could be handled at one dressing of the wheel, and then redressing the grinding wheel and performing the finish-grinding operation. Of course, a sufficient number of dogs should be provided so that the operator does not waste time in picking up the thread in the machine or in dogging the work with relation to the start of the thread. On the other hand, if the thread is of a coarse pitch, the time required for the removal of the metal might make it more economical to mill the thread first and use the thread-grinding machine for the finishing operation only. If the work in question cannot be readily carried on the centers of the machine, but must be mounted on an arbor or a fixture of more or less complicated design and construction, it would probably be found that unless production of these parts were continued over a considerable period of time, the cost of tools or the time of assembling the work on the arbors would make for greater economy if the thread were roughed and finished in one operation.

TYPES OF THREAD-GRINDING MACHINES

If we consider principles of design and construction, we may divide thread-grinding machines into three different types, basing this division on the method used to generate the helix of the thread.

Perhaps the type in more common use today employs a screw of the same pitch as the thread which is to be ground, mounted on the work spindle, and the motion of the table of the machine is developed by the rotation of the work-head spindle and the screw. This construction is relatively simple in principle, and when the worktable is designed to operate freely and without much friction, it is not a difficult problem to maintain a fit between the screw and nut which will permit grinding in both directions. This type of machine is, of course, somewhat limited as to the length of thread to be ground. The screw is usually of the sleeve type and is assembled and keyed to the end of the work spindle; however, since a different screw must be provided for each pitch to be ground, lengths of over 8 or 10 in. are apt to involve considerable expense as well as to make the machine somewhat cumbersome due to the increased length.

A second type of machine, which lends itself to a wider range of work, particularly for longer threads, employs a lead screw and nut, usually mounted under the table, and utilizes change gears to vary the ratio between the spindle and lead screw in order to obtain the required pitch. A machine constructed in this manner is usually equipped either with a quick return to minimize the time lost between cuts or with a compensating device to equalize the backlash in the gears, so that the machine

* This article will be limited to a discussion of threads that are normally utilized for fastening purposes, such as the National form, the Whitworth and the Lowenhertz, as distinct from Acme and worm threads which are as a rule much coarser and of much steeper helix angle, thus becoming more involved and presenting problems of their own.

Contributed by the Machine Shop Practice Division for presentation at the Fall Meeting, Providence, R. I., October 5–7, 1938, of The American Society of Mechanical Engineers.

will grind in both directions with no lost motion at the point of reversal. This design is more frequently used in the larger machines and is somewhat more expensive, since the construction involves a more complicated mechanism.

A third type of machine has been built which is not dependent on a screw for the development of the helical motion of the work. This construction employs either a cam or a wedge similar in construction to the taper attachment of a lathe. With proper geared reduction and either a series of cams or a properly adjustable arrangement for the wedge, any pitch may be developed. This construction, although limited as to the length of thread which may be ground, permits the development of the pitch to very close tolerances and is particularly useful in cases where special pitches of a long or short lead must be developed.

Practically all thread-grinding machines have been constructed along the same general lines as a plain cylindrical grinding machine, in that the head and tailstock are carried on a table with a reciprocating motion, which, of course, is synchronized with the rotation of the work spindle. Some of the heavier machines built in Europe have followed another principle in that the grinding-wheel head traverses forward and back in time with the motion of the work spindle. This latter construction is probably desirable whenever the combined weight of the work and worktable with its attached driving mechanism exceeds by an appreciable amount the weight of the wheel head and dressing mechanism.

Machines intended only for the grinding of straight threads are normally equipped with a plain table carrying a headstock and tailstock, the latter being adjustable in the same manner as the tailstock of a lathe, whereas some machines intended for use in grinding tapered threads have a subtable, similar to that of a plain grinding machine, which may be swiveled to develop the taper required. This construction involves some device, such as a differential or a universal joint, to provide free and uniform rotation of the spindle when the table has been adjusted for the grinding of a taper. The use of a universal joint at this point will involve some slight theoretical errors, but when properly constructed it will eliminate backlash and, for the common taper of $^3/_4$ in. per ft, the errors are so small as to be considered negligible. Another construction developed to permit the grinding of tapered threads employs a taper bar or taper attachment which feeds the wheel head in or causes it to recede as the worktable is reciprocated. This construction embodies the same principle as that of the taper attachment of a lathe.

Since the development of the helix for the grinding of the thread involves the rotation of the spindle and the travel of the table to a very exacting degree of accuracy, perhaps not to exceed a few ten thousandths of an inch, it is necessary that the design and construction of the machine be such as to insure that the spindle revolves uniformly about its axis and that the table travels in a uniformly straight line. This of course can only be accomplished by the use of a spindle and bearings of the highest precision and table ways either very accurately scraped for uniformity and alignment or ground to similar specifications. In many machines, particularly those where the shorter lengths of threads are to be ground, the worktable has been carried on balls or rollers running in hardened and ground steel ways. This method has assisted materially in lightening the load on the lead screw and driving mechanism, and no doubt has helped to give added accuracy and life to the machine.

GRINDING WHEEL-HEAD UNITS

An equally important and interesting part of the mechanism which enters into the thread-grinding machine is the wheel-head unit, which includes the wheel spindle, its bearings, and drive, together with the wheel-dressing mechanism.

The trend in this country of recent years has been toward the larger diameters of wheels, because this gives a greater periphery with a resulting longer cutting life between dressings. The profiling of the wheel and the maintenance of its contour has probably been the most serious and troublesome problem involved in the grinding of threads, but with wheels from 16 to 20 in. in diameter a higher peripheral speed can be maintained, and with the greater circumference a proportionate increase in wheel life between dressings is made possible. This development has undoubtedly increased the cutting qualities of the grinding wheel to the point where the grinding of parts other than taps and gages has proved to be economical.

In Europe, many machines still have wheels of about 12 in. diameter, but it has been the custom there for some time to use multiple wheels with several convolutions dressed in the face of the wheel.

This of course is not desirable unless the quantity is large enough to warrant the spending of some time to set up and dress the wheel, since the contour and pitch must correspond with that of the work. However, with a multiple wheel having from five to ten threads dressed in its periphery, the life between dressings is very much greater than one with a single profile, because the forward portion of the wheel tends to rough the work while the remaining portion will finish to size. By this method threads can be rough- and finish-ground at one pass of the wheel.

WHEEL DRESSING

A German manufacturer of thread-grinding machines has developed a unique method for dressing a multiple wheel. A large disk or drum, which carries a thread of the form and pitch to be ground and has suitable flutes to provide cutting edges, is driven at fairly high speed while the grinding wheel is revolved slowly in front of it. The drum is fed into the grinding wheel to the desired depth, thus the dressing of the wheel is accomplished in a very short time. The drum must carry the same pitch as that to be produced on the work; therefore, a separate drum is required for each pitch, and when changing from one thread to another the wheel must be entirely redressed.

An English concern which has been building thread-grinding machines for a number of years has developed a wheel dresser for profiling a multiple wheel by utilizing a formed diamond and a pantograph device. The thread contour is developed on an enlarged scale to minimize the errors, and then a reduction is obtained by the pantograph mechanism which develops the exact shape and size of profile desired. The size and shape of the diamond must be maintained with an exact ratio to that of the follower, and this must of course correspond to the reduction of motion produced by the pantograph. Either of these dressing devices would be particularly useful in profiling the wheel for the grinding of a Whitworth thread where a radius must be maintained at the root and crest, and the size of the major and minor diameter is maintained with the pitch diameter. The development of the wheel profile for our National thread is not nearly as involved, since we are interested only in the fit of the thread on the angle or flank and in the fact that we wish to be assured that there is some clearance at the major and minor diameter of the thread.

In profiling the single wheel, most of the dressing mechanisms which have been designed depend either on a straight-line motion, developed by a sliding member fitting in a slot or dovetail, or on a slightly circular motion where the diamond travels in a plane parallel to the face being dressed. Diamonds have been used very largely for dressing the form and contour, al-

though some very good results have been secured by using auxiliary spindles carrying smaller wheels of suitable hardness to dress the grinding wheel properly. Since the form at the root of the National thread is unimportant, except that it clears a certain maximum diameter, not so much difficulty is incurred in the dressing of the wheel. A grinding wheel should be selected with a grain size and bond that may be dressed sharp enough to maintain the minor diameter of the thread within the tolerances allowed, and as the wheel becomes dull, the redressing of the sides of the wheel will automatically renew the edge, thus maintaining the proper depth of thread.

In mounting the wheel spindle, a problem is involved that we do not encounter in plain grinding. The helix of the thread to be ground, particularly if it be over 2 deg, must be compensated for if the angle of the thread is to be maintained. The most common method is to support the grinding-wheel spindle as a unit on a swiveling mount that makes possible an adjustment of the spindle to a position at right angles to the helix of the thread. This will allow the wheel to conform to the helix of the work, and if the plane of the dressing mechanism be maintained in a position parallel with the axis of the work spindle, the thread angle will thus be maintained within close tolerances.

The balance and precision of the wheel spindle itself are of the greatest importance, as the slightest tendency toward vibration, looseness, or end play will be reflected in the thread as chattered or rough grinding. Various types of bearings have been used, but suitable proportions and the highest precision are the first consideration.

The grinding of threads for commercial purposes does not seem to have developed as rapidly in the United States as in some of the European countries, although in the small-tool industries, where precision is such a vital factor, just as much progress has been made. This may be due to a combination of circumstances, such as better threading tools, higher wage rates in this country, and perhaps the fact that only recently have any American machine-tool manufacturers offered thread-grinding machines for sale. However, with the interest that has developed in recent years in the improvement in quality of the threaded product and in the possibility of thread grinding as a means of producing higher quality, there is no doubt but that this practice will show a marked increase in years to come.

"THE STRONG SILENT MAN".

Do Scientists and Technologists Speak so Badly in Public?

By S. MARION TUCKER

POLYTECHNIC INSTITUTE OF BROOKLYN

THE SCIENTIST himself, especially the technologist, answers this brutally direct question with a frank and positive "Yes." No mere humble layman would dare to find as much fault with the speaking of scientists and technologists as they themselves find and avow. They are in general inclined to be fair, open-minded men, self-critical, looking always toward improvement both of themselves and of their profession. Plainly, the technologist, especially, is dissatisfied with himself as a public speaker. This did not use to be so. What has happened to him?

Well, in the past he probably had no occasion to speak so often and under such varying conditions; hence he felt no special disability as compared with men of other callings. Perhaps he was so absorbed in mastering his profession, with all its infinite complexities and its daily changes and progress, and so intent upon doing his work well, that he discounted or ignored the very useful science and art of oral communication. But society is making new demands upon him. He feels that he must answer them.

There still survive a few members of the older generation of technologists, able, self-contained, reserved, inarticulate, who represent the now passing attitude toward effective public speaking. They were satisfied to do their work well and let the work speak for itself. It spoke convincingly and eloquently indeed. But times have changed. The day for such proud, and perhaps rather contemptuous, reticence has passed.

The scientist in general, the applied scientist especially, perhaps, is playing a greater and greater part in our modern world. His work, its problems, its methods, its relation to public affairs, is of general interest. We want to know about it. We must know about it. It directly concerns our lives. Of course the scientist and the technologist speak most emphatically by their deeds, but these deeds may have to be explained or may have to be justified. They relate to a complex world of social, political, and economic forces. Then, there will always be the deeds yet to be done, thus far only planned, and these may have to be rendered possible, may have to be brought to birth, by public opinion, understanding, and support.

Eighth in a series of articles on the presentation of technical papers.

AND IS HE REALLY "UNCULTURED?"

Why, in the very name of the scientist's own intelligence and skill, should he need any intermediary to interpret to him the public? Why should he not be his own advocate? Some other professions, with far less of importance to say, express themselves volubly enough. Our immense and highly expressive language, with all its idioms, belongs to him as much as to any other man. He can form as good sentences out of it. He can as easily acquire the devices of interesting and effective speaking as can any other professional worker. He asserts that many outsiders, who of course should know better, look upon him as rather inarticulate and even uncouth, as "unlearned" and "uncultured." These are his own words. Such a taunt is, in general, unfounded and absurd. But if it be really made at all, he has only himself to blame. Any educated person knows that science is as truly "cultural" and "scholarly," as "educative" in the best sense, as are languages and literatures, philosophy, psychology, and all the social sciences. The man who is utterly ignorant of science and its place in the modern world, who has

no interest in it or respect for it, is himself uneducated and uncultured.

IN THE PAST HIS ENVIRONMENT AFFECTED HIM

If the technologist is not so glib of speech as members of other professions, he can justify himself somewhat by the very nature of the material with which he mainly deals. This material is physical, tangible, concrete, definitely to be weighed, measured, put into place, made to do its work. It is unhuman. The scientist and technologist concern themselves primarily with no other material than this. Its qualities, the principles and laws that govern it, have no relation to humanity. Such dealing with concrete material does not easily lead to the study of human nature as of primary importance. It does not conduce to social expansiveness. The technologist, especially, can rely so heavily upon figures, graphic matter, apparatus, exhibits, demonstration of all kinds, for self-expression that he naturally overlooks or discounts the grace and fluency of the collateral resources of rich, flexible, and expressive speech which are right at his hand and belong to him as much as to any man.

And what did his school training do for him in the past? He actually went to college, in the first place, with his bent already determined, his point of view already fixed; only technology counted; only the purely technical had any relation to money-making, to professional success and prestige, or even to interest in living. His curriculum in college gave him the notion, often reinforced by the precept and example of some of his instructors, that a mastery of mere words was beside his purpose and function. He was no mere word monger; he was a doer! Here and there a little, and rather patronizing, attention was grudgingly given to so-called training in speaking, as a suspiciously unprofessional instrument which might possibly prove of some vague use in his future "career." His teachers themselves were seldom effective speakers. With the entire atmosphere of the typical school of science surcharged with contempt for good speaking, or indifference to it, with bad practice all about him, he had everything against him.

His professional experiences and associations later on confirmed this bent rigidly and permanently. Narrow in his outlook as a college student, and with little inclination to broaden that outlook, he now found it essential to make a living, to get on in the world financially and professionally. Inevitably he became engrossed in the technology, so fascinating just in itself, that demanded all his time, energy, and intelligence. Good speaking, simply for the purpose of communicating his thoughts and feelings to others, came not within his ken. It seemed to him something quite apart from his peculiar interests—a special aptitude for those who concerned themselves with lesser things; or, if his attitude was sympathetic and not contemptuous, at best for those who had time and opportunity to amuse themselves with some of the pleasant frills of life. He himself reveled in facts and figures, in plans and deeds.

If he was an extreme case, he was even likely to distrust mere words, the chief vehicle of communication, and hold the entertaining speaker in suspicion *ipso facto*. The more interesting a speaker was, the more he distrusted him. He was very likely to take a rather unintelligently superior attitude toward any attempt to get people to speak better. He seemed to assume that good speaking was not compatible with solid learning, genuine ability, and fine achievement. He cited the "strong silent man," the man of deeds, not words. A fine, impressive phrase, but amusingly misleading. The strong silent man is a mere superstition. Most strong men in the past have been remarkably, almost overwhelmingly, voluble. Even William the Silent was a prodigious talker; so were Caesar, Cromwell, Napoleon, and Lincoln. But perhaps these men were weaklings, after all! Really, the silent man is usually one who has nothing to say, or is afraid to say anything, or actually does not know how to say anything. "Silence is golden," an admirable maxim, means simply that the wise man knows when to keep his mouth shut.

THE NEW DEMAND

But recently has come a vast and illuminating change, Scientists and technologists are now demanding better speaking, with a large comprehension of its right function and its splendid human power. To this growing demand, the schools are beginning to respond, and they respond with alacrity. Students, who quickly sense the attitude of their seniors and of this changing world in general, have come to regard speaking not as an idle ornament but as an essential part of their professional education. Their progressive attitude, it must be confessed, maintains itself in spite of much of the painfully poor speaking and abuse of the language that they hear both from some of their instructors and from very many of their fellow students. This, in the colleges. Outside, training in speaking is being fostered by several of the large industrial corporations, and the great national engineering societies are making a strong, consistent, and never-relaxing effort to encourage it. The tide has turned.

Nesmith

ENGINEERING'S PART *in the* DEVELOPMENT *of* CIVILIZATION

IV—Influence on Civilization of Further Widening of Engineering

By DUGALD C. JACKSON

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

PRIMITIVE MAN captured fire and converted it to his own use, but for long he had no means of renewing it artificially if it expired. Then someone invented the fire maker consisting of flint, pyrite, and tinder and someone also invented the other fire maker that consists of two rubbing sticks and tinder. For those primitive times, these were epoch-making inventions and their use spread from man to man and group to group wherever men made casual contacts with each other. Primitive men, in the paleolithic (early stone) age, gradually became quite skilled as artisans in making for themselves implements and weapons out of stone, bone, horn, and probably of wood. They also made crude pottery. They lived in the open, or in caves, either natural as they found them or extended by their own efforts, or in crude shelters which they made out of saplings and branches.

. . . . they lived in the open or in crude shelters . . . . made out of saplings and branches (Negrito hut, Philippines)

Man's life was on about the same level as the wild beasts, except that men had tools and weapons and (added to instinct) they had power of analyzing simple situations by reasoning, and ultimately they came to possess articulate language. Men, therefore, with these advantages, had somewhat improved their security of life, food, and shelter, as compared with the beasts, by utilizing their own peculiar intelligence available in the prehistoric days; but we can assume the advantage to have been maintained for each individual or family only by constant vigilance and perhaps considerable combat with both beasts and men. The savage use of teeth, fingernails, flying rocks, fists, stone hatchets, and bludgeons, may be imagined as it characterized the man-to-man battles of man's paleolithic days. (The combative spirit inherent in today's man presumably is of lineal descent from his antecedents.)

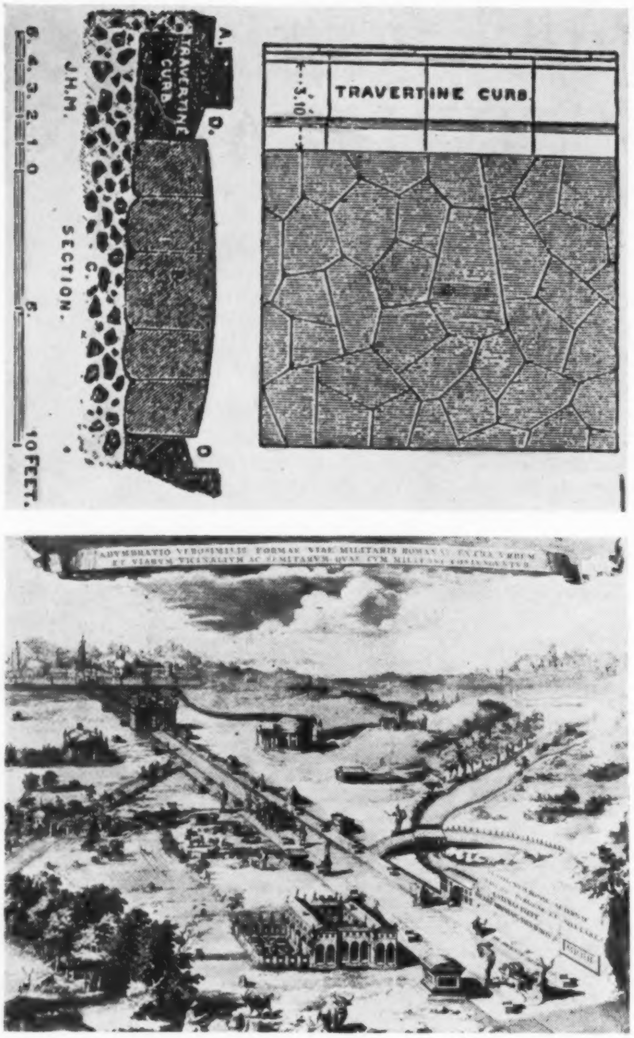
Family ties perhaps grew up by instinct, as with lower animals. Tribal or clan ties, like those of the "pack" among the beasts, probably came later and were maintained by virtue of the leadership of physical prowess supported by a small margin of sagacity. It seems that instinct exists in whatever possesses animal life with any brain development; and, where there is instinct, there apparently always resides suspicion. This is a natural quality associated with instinct. In this situation the definition of suspicion is an innate skepticism of assured good faith on the part of other animate objects. Hence the special need of physical prowess for "group" leadership among primitive men, so that any seeming incipient waywardness of a group-member could be repressed promptly. When community relations (made possible by a developing engineering sense) were later established, these older processes were partially outmoded and a degree of mutuality between the individuals became necessary. Mental qualities then took on larger importance, ethical rules became recognized, and civilization came to be a fact.

The furtive intelligence of early man is worthy of thought. He "out-smarted" the other animals and converted their flesh to food, their bones to implements and weapons, and their skins to garments. He apparently tried to make himself secure and somewhat comfortable. As a hunter and fisher, his life was one of activity and was lived without permanent place of habitation.

He gradually improved his artisanship on implements and weapons, made crude pottery, basketry, and woven mats or textiles, domesticated animals (beginning with the dog but then extending to the ox, ass, goat, pig, sheep, horse, fowl, and the like, in different inhabited districts), did a bit of cultivating of the soil, perhaps some crude irrigating, and a bit of drawing and carving. He also apparently began to generate commerce on land as people moved about, by trading pottery for flintstones, and other suchlike examples of barter. By adding the directive influence of experience to his intelligence he invented the wheeled vehicle, built up some engineered villages, constructed boats, learned a little metallurgy, and gradually ceased in part the roaming, nomadic life. From the paleolithic or old stone age he developed through a neolithic or higher stone age and then through a copper and bronze age and the opening of an iron age to the invention of interpretable, descriptional inscriptions or written language. Then was the dawn of the period of history, as it already has been described. These developments did not occur simultaneously among the populations scattered about the world.

Archaeologists, reading their chronology from geological

Fourth of a series of six lectures on this subject delivered at the University of North Carolina State College of Agriculture and Engineering, Raleigh, N. C., Jan. 21 to 29, 1938. The third lecture was published in MECHANICAL ENGINEERING for August, 1938.



. . . . the influence of the Roman Empire carried (over permanently built roads and by ships at sea) commerce and the Roman alphabet to wide areas of the earth. Plan and section of a Roman road, and a view of an old Roman military road.
(From Encyclopedia Brittanica, eleventh edition, vol. 23, page 588; and Reports of Smithsonian Institution)

sequences, say that this rise in the scale of conditions took unnumbered thousands of years for which they give different estimates, ranging up to half a million or more years. Since then (i.e., the dawn of history) the records show that history has been less than six thousand years in achieveing our date of 1937. Engineering has grown strong and effective during that period, and many of the most important ethical characteristics of our civilization have arisen therein.

Breasted[1] said of Egypt:

> The evidences for studying the earlier ethical development of such an ancient people are very scanty until we reach the introduction of writing and the production of written sources. The earliest of these do not begin to serve us in Egypt until after 3000 B.C. . . . . . But the written sources can never carry us back to the beginning of the development.

This date given by Breasted reaches back less than five thousand years from today. Further discoveries in Mesopotamia and elsewhere are not likely to add another thousand years to the antiquity of written records.

As the centuries of prehistory unrolled toward this dawn of history (when written records first became available for the enlightenment equally of the then people and of future generations), men came more and more to expand their activities by guiding their intelligence through the consequences of widening experience. Copper came in as a partial substitute for stone as a material from which to make implements, bronze rather promptly was substituted for copper, and iron was finally finding some use. Metallurgy came into being as a developing art, and other engineering arts developed. The stage was set for faster changes in the historic period.

The pre-Christian period of the age of history was one of accelerating development. The art of navigation was actively embraced and commerce briskly grew by sea. The Minoans and the Phoenicians, and perhaps others, were active in the engineering arts which made them masters of sea-borne commerce during the last two thousand years of pre-Christian history. When the Dorian invasion crushed the Minoans, the Phoenicians carried on. They played the parts of pirates and kidnapers when opportunity favored; apparently they were liars competent for the diplomatic days of Tallyrand, Metternich, and Bismarck; but it is obvious that the Phoenicians had learned that honesty is the best policy and they acted on that principle where trade was permanent and it served their interest.

The influence of community developments which had arisen in Egypt and Mesopotamia, and knowledge of the engineering arts required to support those developments, were spread abroad during the voyages of the traders. The Oxford professor, Rawlinson,[2] who made a particular study of the Phoenicians, said of them:

> They were the great pioneers of civilization. Intrepid, inventive, enterprising, they at once made great progress in the arts themselves, and carried their knowledge, their active habits, and their commercial instincts into the remotest regions of the old continent. They exercised a stimulating, refining, and civilizing influence wherever they went. . . . . . . They united the various races of men by the friendly links of mutual advantage and mutual dependence, conciliated them, softened them, humanized them.

People to whom are attributed (as has been the case of the Phoenicians) both a capacity for hardest work and a love of dreamy ease are just the ones to be appreciative of improvements which come to their attention and to be fertile in invention.

After the Dorian invasion, the reorganized Greeks came forward as architects, artists, and statesmen. Then the influence of the Roman Empire carried (over permanently built roads on land and by ships at sea) commerce and the Roman alphabet into wide areas of the earth. This dissemination of the uniform alphabet among widely separated peoples was a magnificent contribution to increasing the sense of mutuality among diverse peoples. Unhappily the Romans, as they withdrew from their far-flung outlying empire, did not leave behind them a legacy of uniform language spoken by the various peoples. Uniformity of thinking, and affection for the same objects and causes, make tremendous contributions to mutuality of interest among people and thus to civilization, and this dissemination of a uniform alphabet over a considerable part of Europe was only second in effectiveness to what might have arisen from uniformity of language.

Development of shipbuilding and navigation in European nations throughout historical times resulted in increasing com-

[1] "The Dawn of Conscience," by J. H. Breasted, Charles Scribner's Sons, New York, N. Y., 1934, page 23.

[2] "History of Phoenicia," by George Rawlinson, Longmans, Green and Co., London, 1889, page 552.

merce, and finally (in the 15th and 16th centuries of the Christian era) thrust on the world those great enterprises which followed the discovery of America, the reaching of India from Europe by sea, and the circumnavigation of the globe. Commerce grew, but with it grew a hunger for personal wealth that joined with religious intolerance to snuff out for a period the broadening of mutuality which the opportunities warranted. The increasing activities of commerce gave an incentive for the invention of machines and produced a momentary, unfilled opportunity for the use of a readier mode of disseminating knowledge. In the meantime the use of movable type had been originated. We need not consider the rival claims of Germany and Holland as the seat of this invention. In any event a claim is made in China for the invention at a much earlier date than in Europe. But we must emphasize the fact that the engineering skill put into developing the printing press, when associated with the conception of movable type, made a contribution to the processes of disseminating knowledge and thereby to securing mutuality of thought among peoples that is unique in its completeness.

. . . . man made a great step forward when he accepted the concept of a God designed in his own image in place of gods designed in the form of hydra-headed animals . . . .

All engineering works—road building, bridge building, water supply, drainage, regulation of rivers, construction of canals, improvement of harbors, construction of lighthouses to safeguard navigation, erection of great structures, and others—play an important part in bringing people into more intimate personal contact by increasing community life or by enabling it to subsist, and by associating rural populations and community populations in some intimacy with each other. Machines provide the capstone in this development. The 18th and 19th centuries of the Christian era saw a speedy development of machines and rapid spread of their use. Engineers became more numerous and more specialized. Their professional relations spread into additional fields. Machines for spinning, weaving, and sewing, which could be driven by mechanical, as distinguished from human or animal, power came into being; power machines for cutting and shaping wood and metals found a place; grinding grain and other food preparations became active functions of power machines, as also did the processing of many agricultural products; water wheels were put into use; steam power rose as a mighty influence; the steam ship and the steam railroad changed the conditions of mutual contacts within each nation and between nations; machinery competent in extensive manufacturing of steel came into being; improved machinery for mining and the extractive industries was developed; electrical and electromagnetic machinery and devices revolutionized conditions already existing. Internal-combustion engines later contributed much to the revolution.

Some people who claim authoritative knowledge of commerce, finance, or literature have asserted that this use of machines has been injurious to the interests of civilization, because its speedy expansion has disturbed previously established mutual relations among peoples. This point of view partly arises out of the traditional tendency of philosophers to think of the present as decadent as compared with the past; but it also has been the serious expression of opinion of careful thinkers who are concerned about our times. The validity of the assertion therefore is a matter for us here to examine since it tacitly denies our thesis that civilization arises as a consequence of, and grows up with, engineering.

Crude agriculture, hunting, fishing, and crude artisanship maintain the savages, but I think that we all will agree that the greater desires of civilized men require the addition of products from organized manufacturing processes such as are characteristic of the engineering industries. The question then arises as to whether we have been overdoing the latter or have been going ahead at too rapid a pace. When thinking of this we must also remember that established security of life and livelihood in a growing population includes security in producing new applications of knowledge and in pursuing additional knowledge. We must also remember that with increasing commerce, the demand for a variety of goods increases in man's mind and realization of that aspiration rests on diversification of agricultural productions and the development of diversification of mass production in industry.

Man made a great step forward in the path toward establishing his own dignity as compared with dumb animals when he accepted the concept of a God designed in his own image in place of gods conceived in the form of hydra-headed animals, phalli, drunken spirits, or other such grotesque or repulsive images. Again, he made an important but lesser step toward the establishment of his own comparative dignity when he lifted physical exertions from his own muscles and transferred them to machines, thus demonstrating as his own those prime qualities of originality and resourcefulness which dumb beasts do not possess. It is therefore pertinent to ask (as just suggested): Did the use of machines contribute to civilization in a manner similar to the contributions which arose from engineered communities, shipbuilding, road building, transportation, and commerce?

So competent an observer of the Elizabethan Age as Francis Bacon expressed himself in pessimism as follows:

> The World's a bubble, and the life of man
> Less than a span;
> In his conception wretched; from the womb,
> So to the tomb;
> Curst from the cradle, and brought up to years
> With cares and fears.

At the time those words were written, the great sea commerce of the 16th century was flowing strongly, but land transportation in the northern countries was still so poor that little contact or community of interest appeared between the seacoast cities and the inland areas, even in Great Britain, and machinery driven by mechanical power was scarcely foreseen in dreams. This is worthy of considerable thought and attention.

As late as the 17th century, the price for carrying goods be-

. . . . smiling rural areas of Sweden . . . a present contrast to 17th century scenes . . .

tween Leeds and London (about 175 miles) was 13 pounds (English money) a ton. When Smollet, the novelist, traveled from Glasgow to London in the middle of the 18th century the facilities for transportation were so crude that he is alleged (perforce) to have made part of his way by wagon, part by pack horse, and part on foot. It is said that in 1753 the roads near Leeds (in England) consisted of narrow hollow ways which barely afforded passage for one vehicle drawn by horses in tandem. The goods of the district were nearly all carried along these roads by pack horses.

Smiles, in his interesting work entitled, "Lives of the Engineers," published some seventy-five years ago, says of England:

It is curious to find that down even to the beginning of the seventeenth century the inhabitants of the southern districts of the island regarded those of the north as a kind of ogres. Lancashire was supposed to be almost impenetrable—as indeed it was to considerable extent—and inhabited by a half-savage race.

A century later, says Smiles, the vicar of Cheriton in Kent, setting out in the springtime as soon as the roads became passable, entered upon a series of travels in England:

. . . as if it had been a newly discovered country . . .
His friends convoyed him on the first stage of his journey, and left him, commending him to the care of Providence. He was, however, careful to employ guides to conduct him from one place to another, and in the course of his three years' travels [as described in a book entitled "Three Years' Travels in England, Scotland and Wales" which was published in 1726], he saw many new and wonderful things; but when winter and wet weather set in, he was compelled to suspend his travelling and lay up, like an arctic voyager, for several months, until spring came round again. He passed through Northumberland into Scotland, down the western side of the island towards Devonshire, where he found the farmers gathering in their corn upon horseback, the roads being so narrow that is was impossible for them to use waggons. He desired to travel into Cornwall, the boundaries of which he reached, but was prevented proceeding farther by the rains, and accordingly made the best of his way homewards.

Smiles goes on by describing the problem of household supplies, in the 17th century, more or less following old records of William Camden: "People knew little except their own narrow district. The world beyond was as good as closed against them," and the seclusion resulted in considerable habits of brutality. Of course, home industry was relied on for clothing, and the reliance for food in winter was mainly on grain in the granary, cellar-stored vegetables and home-salted meat or fish.

There were no shops in the smaller towns or villages, and comparatively few in the larger: even these being badly furnished with articles in general use. The country people were irregularly supplied by hawkers, who sometimes bore their stocks upon their backs, and occasionally on pack horses. . . . . In autumn the mistress of the household was accustomed to lay in a store of articles sufficient to serve for the entire winter. It was like laying in a stock of provisions and clothing for a siege during the time that the roads were closed. . . . . There was also the winter's stock of firewood to be provided, and the rushes with which to strew the floors—carpets being a comparatively recent invention; besides, there was the store of wheat and barley for bread, the malt for ale, the honey for sweetening [then used for sugar], the salt, the spiceries and savoury herbs so much employed in the ancient cookery. When the stores were laid in, the housewife was in a position to bid defiance to bad roads for six months to come. This was the case with the well-to-do; but the poorer classes, who could not lay in a store for winter, were often very badly off for food and fuel, and in many hard seasons, they literally starved [notwithstanding such charity as they might be able to obtain from distant but more fortunate neighbors. In those circumstances the dependency of the aged and infirm among the poorer people was cruel to a degree.].

The foregoing describes the condition of communications at the opening of the 18th century in what, in our present day, is a smiling and productive country with a large well-fed, well-clothed, and fairly well-housed population. The reports of the living conditions of the 17th and 18th century population, which was then of far lesser numbers than now, show hardships, lack of education, and sordidness to a degree difficult for us to conceive.

Old reports show like conditions of two or three hundred years ago existing in the now most smiling rural areas of Sweden and other countries. The isolation of some districts was so great that a local crop failure resulted in famines causing starvation. Such famines occurred in western Ireland even as lately as when I was a boy. Famines in wide districts, which caused tremendous devastation, were common in India until the advent of the railroads which could carry supplies, and of telegraphs through which the world's conscience was aroused. Widespread death from famine still occurs in large areas of China because of the lack of these ameliorating engineering agencies. It is worth while to note that in India, where failure of crops over wide areas is not uncommon and much experience has been accumulated regarding measures to be taken for relief among the very poor people living there, it has been found that strict precautions must be taken to prevent undermining the independence of the people aided.

Engineering works—good structures for shelter, hard-surfaced roads, railroads, water control, telegraphs, telephones, radio, metallurgical processes, steam power, automobiles, good artificial illumination, and the like—have conjointly lifted the European populations previously referred to, from sordid poverty and marginal living to a condition of relative security of livelihood and happiness by making mutual contacts easy for the people, increasing mutually sympathetic relations, and assuring prompt transportation of goods when and where needed or desired. Besides mining and the extractive industries, the addi-

tional engineering works of manufacturers' machinery, agricultural machinery, artificial fertilizers, and synthetic products add means for producing sufficient supplies of good quality to meet consumption and to encourage its increase when increase may lead to comfort and happiness. Along with these goes sanitation, another feature of engineering, which is an essential foundation for preventive medicine and fairly sustained health with its increase of happiness. As health and comfort are more securely established, hours for recreation found, and education spread at large, the asperities arising from competitive contacts seem to soften, and mutuality of interests becomes more fully recognized and observed. That is, ethical relationships become more deeply implanted. The use of machines has played an important part in aid of the development of this result.

The 18th and 19th centuries produced a tremendous growth in the use of power-driven machinery in the processes of manufacturing, the power being provided either by water wheels or reciprocating steam-engines. Notable progress was made in lifting cotton spinning and weaving from a household industry of woefully long hours in which men, women, and children prepared the fibers, spun the yarn, and wove the fabrics by hand, in addition to carrying on the usual work of farming a few acres, by which they gained a slim and precarious livelihood. With the advent of power-driven machinery, power-driven spindles and looms were concentrated in factories. Thus began the so-called factory system, which long was bitterly attacked on the ground of its requiring over-long work hours, improper use of child labor, and unguarded dangerous machinery. The justification of the early attacks is proved by the unremitting improvement of the conditions which has been effected decade by decade. The trail of improvement still continues, and the living conditions of workers have changed so greatly for the better as to make comparisons substantially impracticable.

It is worthy of comment at this point that well-intending impartial men of intelligence believed, when factories were new, that the factory system, inclusive of the long hours for employees and the employment of children of tender ages, would improve the living conditions of the workers and the workers' families compared with the sweat-shop conditions of the then existing home industries; and that has proved true in spite of the abuses which also came in, and which have not yet been fully eradicated. We still insist in this day that more favorable conditions shall be set up in the treatment of youth, although our child-labor situation is incomparably less objectionable than the heart-rending conditions both before and immediately after the introduction of power-driven machinery, about a century ago.

The conception, development, and advantageous use of power-driven machinery requires a much larger proportion of creative brain power than does reliance on muscle power. The developments have introduced (as I pointed out several years ago[3]) a new kind of *division of labor*, which is the substitution of the forces of mechanical power in the place of muscular power, with a marked consequent emphasis on mental skill. This is in striking contrast with the old division of labor which merely shifted the application of muscular forces from man to man. A better term than division of labor for representing modern conditions is ***adaptation of labor***. The dignity and power of the human mind makes it appropriate to relieve man labor by substitution of machine labor in drudge work, and engineering invention is accomplishing the result. The contrast of the miserable state of the coolie rickshaw pullers and their families in the Orient with the conditions of occidental automobile chauffeurs pictures the result. History has shown that every step in such changes increases mental alertness, interest in education, extent of leisure, and other qualities which tend toward smoothing jealousies and improving the ethical relations among men. The advantages are not uniformly spread, and much effort is yet due to make a fair spread, but the advantages are there nevertheless.

Do you question the increased extent of leisure which—out of the engineering developments—has resulted for those who struggle daily for the livelihood of themselves and their families? Let me give you just two illustrations out of the innumerable ones that could be brought to bear. At the end of the 18th century a farmer in western Pennsylvania sent his wrought-iron plow shares by horse-drawn stage 42 miles for sharpening. About the same period it was usual to plow from sun-up to sun-down with a cessation of perhaps an hour and a half at midday so that the draft animals could feed and rest. In those days muscle work was still preeminent. Mechanical power on the farm has immensely improved this.

Again, in my boyhood (the early part of the last third of the 19th century) the usual factory working hours of a mechanic were 60 or more per week. Now with increased use of machinery, they are 48, 44, or even 40 hours per week, associated with increased production and concurrent increased relative and actual compensation for the workers, besides increased time for relaxation and recreation. It is impossible to assert that the increased number of hours, free for reflection and recreation as a consequence of the shorter workhours, are all utilized desirably or indeed all honestly; but a large proportion of them are well used.

Those who allege, as some do, that the general introduction

. . . . the dignity and power of the human mind makes it appropriate to relieve man labor by substitution of machine labor in drudge work, and engineering invention is accomplishing the result . . . .

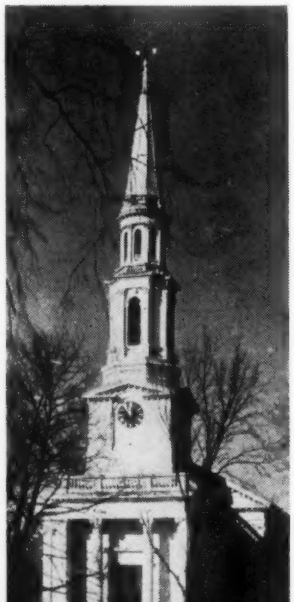
[3] "Stabilization of Employment," report of Symposium of A.A.A.S., December, 1932, edited by Chas. F. Roos, The Principia Press, Bloomington, Ind., 1933, p. 42.

of machinery has widened the gap between men of different walks of life, by causing an unfair and contrasting possession of wealth and an over-all instability of employment, compared with earlier times, must have failed to examine the facts and their relations, upon which the truth of such allegations must rest. Observation and figures, such as exist, show that the opposite effects have been operative in America and western Europe during the period of developing use of power-driven machinery. They further indicate that no such disparity of wealth or control of life, between individuals, now exists in these western countries (unless it be in certain so-called totalitarian nations) as the disparities which characterized the feudal age in Europe and still characterize certain Eastern countries where life is established under the mantle of ancient influences and where modern science has little penetrated. Moreover, in this country at least, we have no peasant class and conditions of our lives press upon all classes of our citizens a recognition of mutuality in their interests. For example it is said that "factory payrolls and farm income from live stock vary directly with one another" in the United States.

As thus analyzed we can see that engineering is a principal liaison between social development and both the practical experience and the research that goes on in the field of physical sciences. This does not leave a mandate with us for laziness, although through engineering we secure shorter hours of formal work and more time for reflection and recreation while obtaining sufficient compensation. A competent designer of machines or structures must dip his bucket into the well of creative thought if he wishes to add effectually to our now existing processes, and this demands concentration of purpose and effort which is the antithesis of laziness or dawdling. The same is true of most other occupations that are touched by engineering. Indeed, a doctrine of no-work is destructive of engineering projects and therefore is subversive of all good that resides in civilization. Yet we find such a doctrine now and then expressed by those who ought to know better.

The expressions of the doctrine sometimes sound like satire, although meant in deadly earnest. The idea ignores the major fact that increase of material wealth is gained fundamentally from what is grown on the surface of the earth or taken from within the earth, from the waters of the earth, and from the air surrounding the earth; and that the processes of securing the wealth require muscular and mechanical power directed by the mind of man, the efficiency of which direction depends on the effectiveness of man's education and experience. Other sources of wealth are collateral and become sterile if the fundamental sources dry up. For the populations to cease work and manners of thrift would mean that they would cease to live in even moderate security; and, unless we keep our machines in operation and continuing to develop, we cannot live in the increasing leisure and plenty that is an ideal among western populations, evolved in different degrees in different nations, but existing in all.

Happily, we all hope to live with security of life and livelihood and when Hope, enchanting, has smiled and beckoned along a route, man has followed. This has been true, whether in prehistoric times or the most modern age. Community habits made possible by engineering provide opportunity for the exercise of man's social instinct for companionly fellowship, combined with the exercise of man's developed sense of group welfare associated with self-protection for the individual. We have developed engineering, we have improved conditions of life that are available in communities, we have enlarged contacts between people in rural areas; ethical practices and specific moral actions have grown to be habits along with the closer contacts; and the quality of civilization has continued to improve. Desirable levels have not been reached in all areas, and much is yet to be accomplished everywhere; but the future lies before us in hopefulness. This, and not pessimism, is the foundation on which we should work. An obstruction to the rise on to improved levels of civilization is the tenacity with which unintelligent specific habits often hold sway over the minds and affairs of men long after being condemned by intelligence. In periods of excitement or stress, indeed, habits not uncommonly override all restraining influences of intelligence. It is still a difficult affair to secure an uninterruptedly controlling influence for real intelligence in human affairs.



....Community habits, made possible by engineering, exercise man's social instinct.

Dr. Heiser says that the bubonic plague (then called the Black Death) attacked Europe in the middle of the 14th century and within a year between a quarter and a half of the population of Europe died. That was six centuries ago. With our present intimacy of contacts and enlarged sympathies, added to our increased knowledge and the availability of machines to manufacture supplies, would such a situation be allowed to recur? The prompt answer in the negative to that question is significant of the improved quality of civilization which is ours because of the growth of engineering and of our ethical relations in their many and widened aspects.

When men deliberately abuse their advantages, as by using machines and their products in making war, the condemnation should be aimed at the consciences of men and not at the machines. Other abuses which are often strongly and properly denounced usually can be cured by negotiation between those having seemingly opposing but actually mutual interests, succeeded by moderate measures of regulation. This is a modern outcome of ethical relations produced by the influence of engineering. Some four hundred years before Christ, even the idealist Euripides saw no occupation so worthy of red-blooded men as war; nor saw deceit as unworthy of the leading gods.

Two thirds of the people of the United States are well-fed, well-clothed, well-housed and have opportunities for education and recreation. They normally are secure in their assurance that the condition will continue. It is a problem of our civilization to maintain the security of that assurance along with a possibility of betterment and at the same time bring the remaining third to a satisfactory level. This certainly cannot be accomplished by dragging down the level of the two thirds, as the present tax practice of our nation threatens to do. I cannot refrain from quoting one sentence from an editorial contained in a recent issue of a weekly magazine of large circulation: "Politics unchecked by economics is a shorter cut to Gehenna than economics unchecked by politics." The one way that experience has proved to be practicable in solving the problem is to encourage industry and thrift in everyone physically and mentally able to practice those virtues and to guide and guard the procedure of the less able.

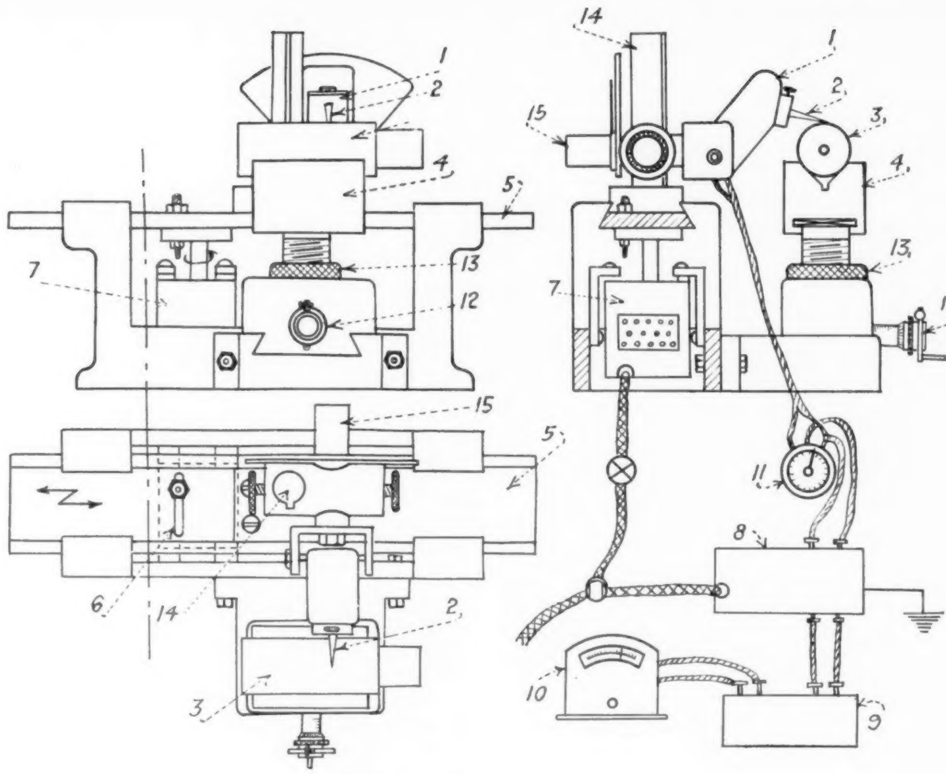


FIG. 1 THE NEW SMOOTHNESS TESTER

A NEW SMOOTHNESS TESTER

Another Method of Measuring Surface Roughness

By YAEKICHI SEKIGUCHI and ICHIRO HASEGAWA

TOKYO UNIVERSITY OF ENGINEERING, TOKYO, JAPAN

IN THE manufacture of machinery the surface finish of some parts has an important effect upon the performance of the machine as a whole. No matter how accurately the parts may be finished to required dimensions, it is difficult to attain the desired result if the quality of the surface finish of the parts is not satisfactory. The accuracy of dimensions is measured with various instruments, limit gages, etc. The quality of the finished surface, viz., smoothness, should also be measured by means of measuring apparatus as exactly as dimensions, in order to insure the manufacture of precision machines.

In recent years this subject has attracted the attention of more and more technicians of various countries, and surface-quality measuring instruments of various types have been devised and introduced into industry. Fairly good results have been obtained from each one. Of the various types of measuring instruments, one uses the method[1] of bringing a needle in contact with the surface to be examined. G. Schmaltz introduced a method based on this principle, in which the movements of the needle were recorded by means of a mirror which simplified the fluctuations.

Later, W. Kiesewetter[2] devised a method called *Kreuzfeder*, which reduces the pressure of the needle on the surface to be tested, and carried out several experiments with an optical measuring instrument to which he applied his method. Besides these, various other methods of measurement, based on the optical-section and reflected-rays plan invented by G. Schmaltz,[3] have been devised and are used in various instruments. Another method was invented by Harrison[4] in

[1] "Über Glätte und Ebenheit als physikalisches und physiologisches Problem," by G. Schmaltz, *Zeitschrift des Vereines deutscher Ingenieure*, vol. 73, 1929, p. 1461.

[2] "Untersuchung verschiedener Methoden zur Bestimmung der Unebenheiten (Rauhigkeiten) von Metallflächen," by W. Kiesewetter, *Diss Dresden*, 1931.

"Über ein neues Mikroskop zur Oberflächenprüfung," by G. Schmaltz, *Zeiss Nachrichten*, vol. 1, no. 7, July, 1934, p. 6.

[3] "Eine Methode zur Darstellung der Profilkurvenrauher Oberflächen," by G. Schmaltz, *Naturwissenschaften*, vol. 20, 1932, pp. 315–316.

[4] "A Survey of Surface Quality Standards and Tolerance Costs Based on 1924–1930 Precision-Grinding Practice," by R. E. W. Harrison. Trans., A.S.M.E., vol. 53, 1931, MSP-53-12.

"A Survey of Surface Quality Standards and a Study of Tolerance

which the movements of the needle are measured and electrically amplified. He used for this purpose an ordinary electromagnetic phonograph pickup unit.

The authors of this paper have developed a method of measuring surface roughness which is different from any of those already mentioned. A description of this new method is given in this paper.

A needle is set at an angle of about 80 degrees to the normal line on the surface to be tested with the curved part near the point of the needle in contact with the surface. By means of a rectilinear reciprocating motion, the needle vibrates along the unevenness of the surface. These vibrations are transmitted to one end of a pair of Rochelle-salt crystals, the other end being fixed and thus generate piezoelectricity. The piezoelectric variations are amplified electrically and recorded by means of an ammeter or an oscillograph, which thereby measures the smoothness of the surface.

Costs,'' by R. E. W. Harrison, *A.S.A. Bulletin*, vol. 2, no. 67, November, 1931, p. 4.

This method is similar to Schmaltz's in which the needle is brought in contact with the surface, but is different in that the needle vibrates according to the unevenness of the surface, with the smoothness being determined from the magnitude of the vibrations.

CONSTRUCTION AND FUNCTION OF THE MEASURING INSTRUMENT

The mechanical construction of the apparatus is shown in Fig. 1. A pair of crystallized Rochelle-salt plates (1), also shown in Fig. 2, is supported in a manner which makes it capable of being moved up and down by means of a pivot. A steel phonograph needle (2) is attached to the Rochelle-salt crystal so that its point inclines approximately 80 degrees to the normal line of the surface to be tested. Supporting rods (14 and 15) allow the positions of the plate and needle to be regulated vertically and around the axis of the vertical rod. A flat table (5) is supported so that it is capable of reciprocating from side to side. The supporting rod (14) is fixed on it. The table (5) is provided with a narrow groove (6) which is at right angles to the direction of the motion. A synchronous motor (7), 78 rpm, is fixed to the lower part of the guide plate,

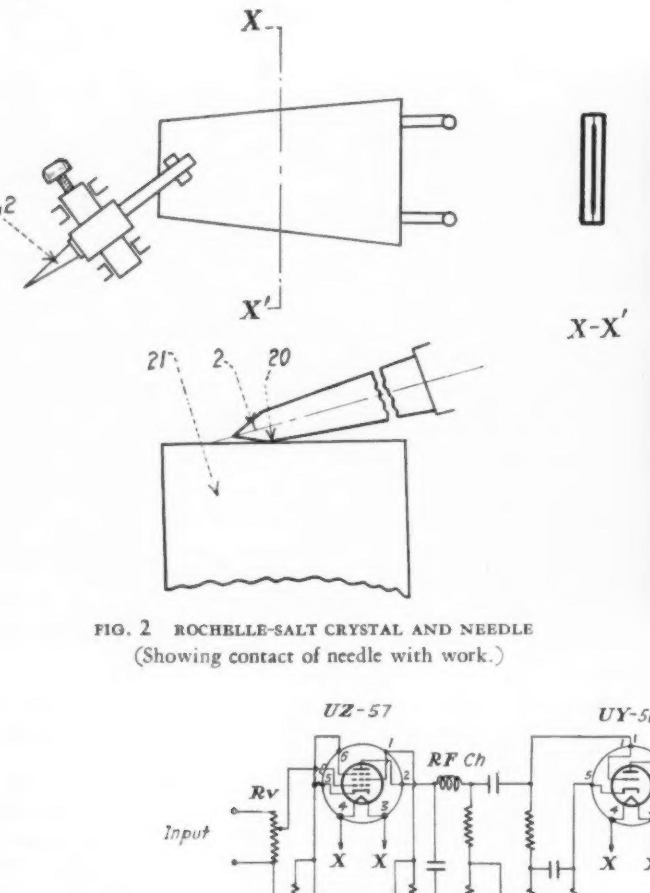


FIG. 2 ROCHELLE-SALT CRYSTAL AND NEEDLE
(Showing contact of needle with work.)

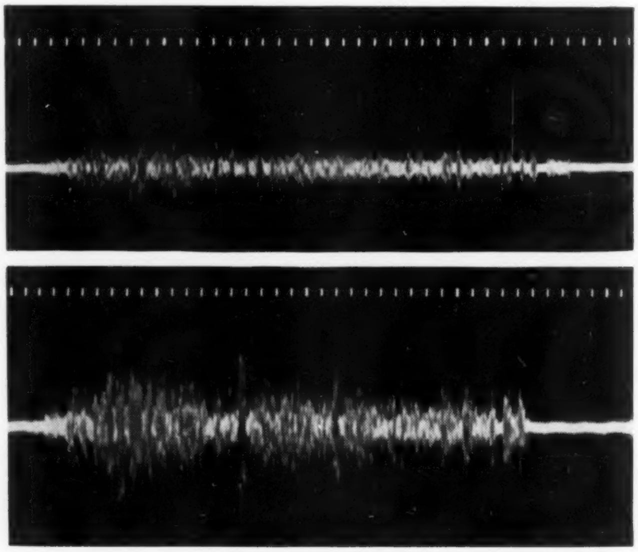


FIG. 4 OSCILLOGRAMS OF NEEDLE VIBRATIONS

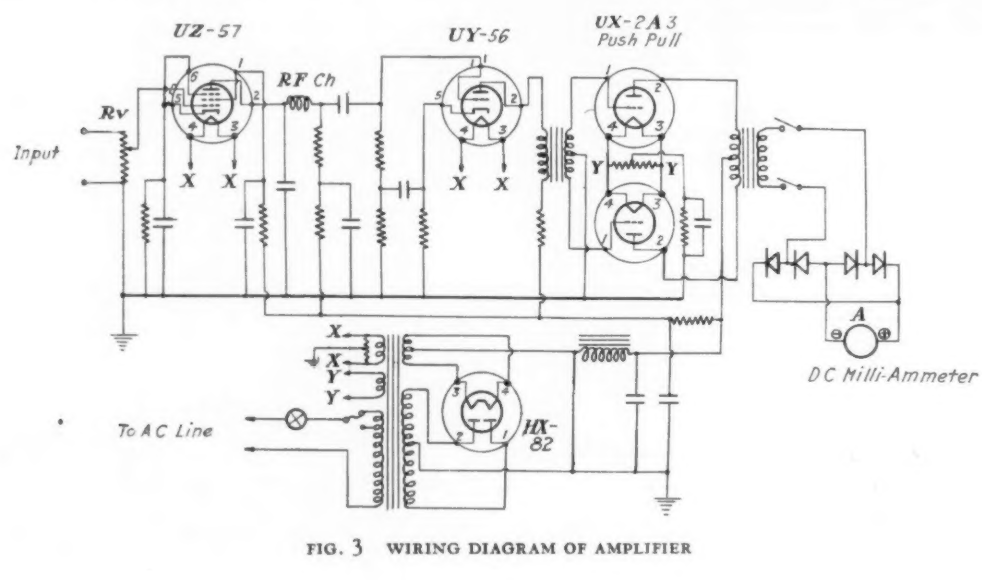


FIG. 3 WIRING DIAGRAM OF AMPLIFIER

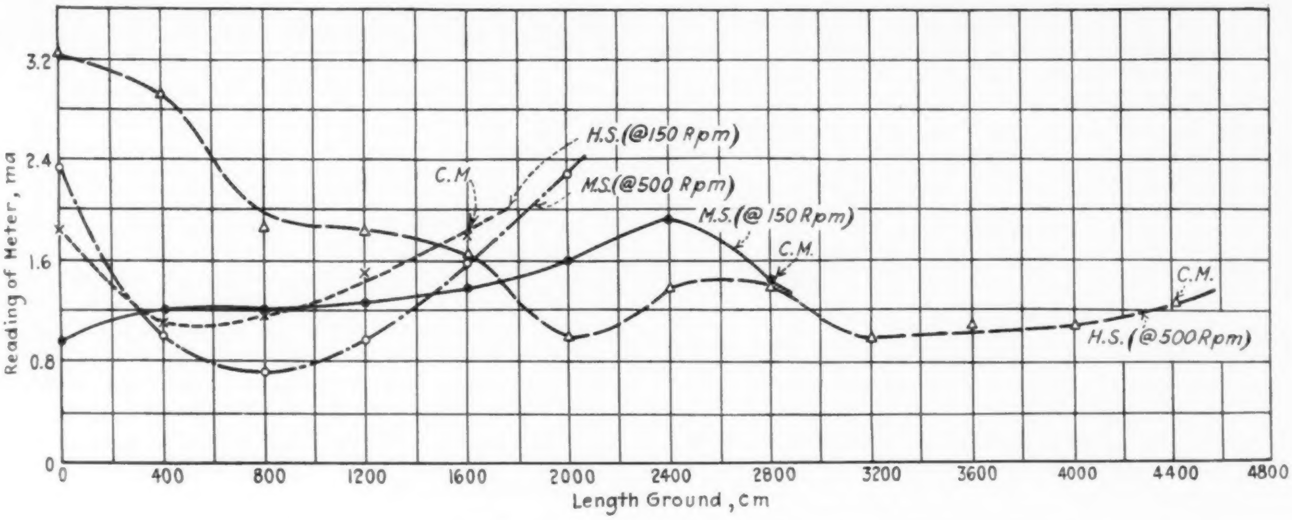


FIG. 7 RELATION OF SMOOTHNESS TO LENGTH GROUND WITH ALUNDUM, GRAIN 80, GRADE L

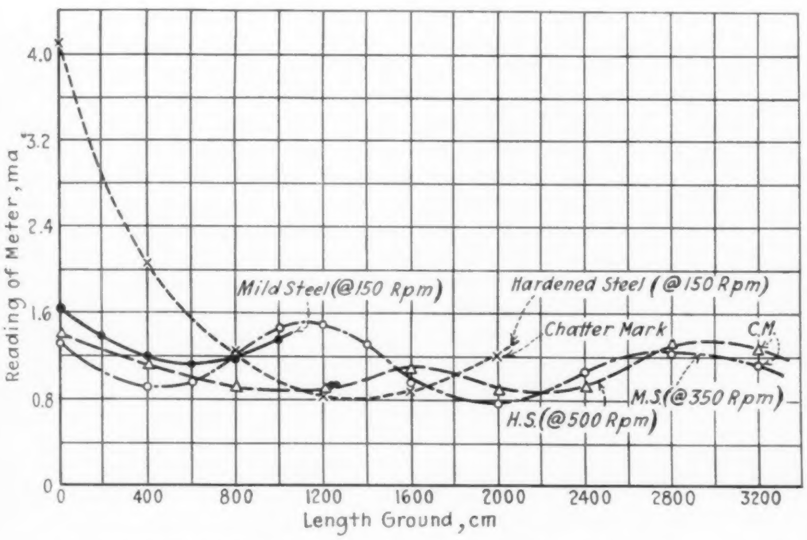


FIG. 6 RELATION OF SMOOTHNESS TO LENGTH GROUND WITH ALUNDUM, GRAIN 100, GRADE UNKNOWN

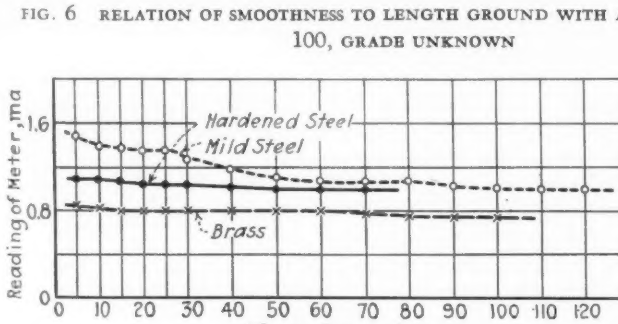


FIG. 5 NEEDLE WEAR OVER A PERIOD OF TIME

and the end of a bolt, which is attached to a plate fixed to the shaft of the motor, is inserted into the groove (6).

As the motor revolves, the table (5) is given a reciprocating motion from side to side at the rate of 78 times a minute. A round test rod (3) is placed on the top of the V-block (4). The vertical position of the block is regulated by means of the nut (13), and the backward and forward position of it, in relation to the needle, is regulated by means of the screw (12). Other parts are a rheostat (11), an electric amplifying unit (8), a cuprous-oxide rectifier (9), and a milliammeter (10). The diagram of the amplifying unit is shown in Fig. 3. The output has been rectified by means of the cuprous-oxide rectifier and measured with the milliammeter.

In the authors' instrument the test needle, as shown in Fig. 2, is at an angle to the surface to be tested so that it comes in contact with the surface not at the needle point but at the corner (20) which is just back of the point of the needle. In this way the vibrations caused by the motion of the needle from side to side along the surface to be tested are stabilized, and are made horizontal in direction. If the needle point were brought in contact directly with the surface being tested, vibrations caused by the unevenness of the surface would become extremely irregular, the wear of the needle would be great, and it is very likely that scratches would be left on the surface.

In the new measuring instrument, the motion of the needle on the surface is a simple harmonic of which the amplitude is of the value of 20 mm, the number of oscillations is 78 per min, average velocity 3.12 m per min, and maximum velocity 4.90 m per min. The authors also took oscillograph records of the piezoelectric variations generated on the crystal by the simple harmonic motion of the needle, as shown in Fig. 4. Thus the variations of electric current are nearly constant, with the exception of the initial and final part where the velocity is small. This is because piezoelectricity is related to the pressure applied to the crystal only and has nothing to do with velocity.

As the needle is given many reciprocations in succession while in contact with the surface being tested, the degree of wear of the needle and that of the surface being tested must be ascertained from the readings of the meter. Fig. 5 shows the results of wear tests. Variation in smoothness against time differs according to the material being tested. In the case of mild steel, variations in the deflection of the meter are comparatively great; but in the case of hardened steel, they are almost nil. In the case of brass, the variations are extremely small. Based

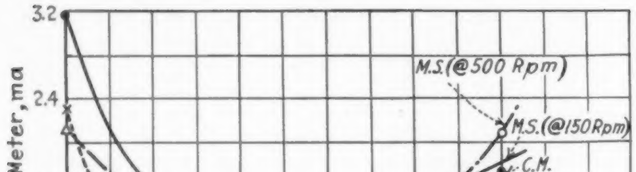


FIG. 8 RELATION OF SMOOTHNESS TO LENGTH GROUND WITH ALUNDUM, GRAIN 80, GRADE M

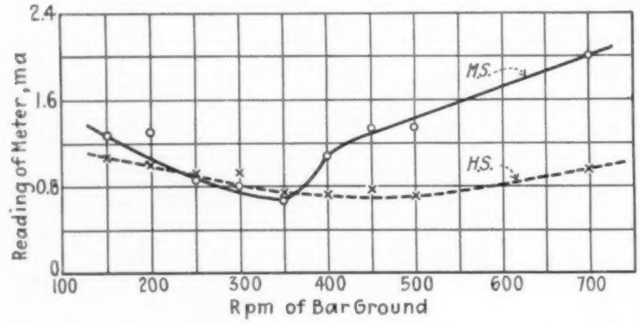


FIG. 9 RELATION OF SMOOTHNESS TO REVOLUTIONS OF WORK WITH ALUNDUM WHEEL, GRAIN 100, GRADE UNKNOWN

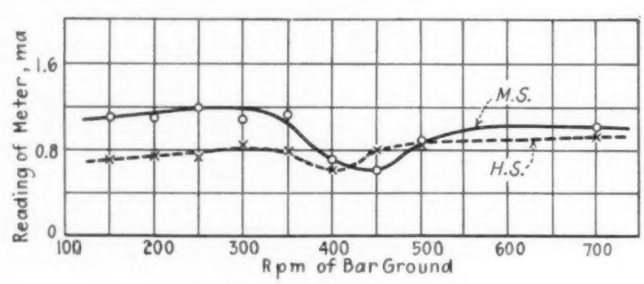


FIG. 10 RELATION OF SMOOTHNESS TO REVOLUTIONS OF WORK WITH ALUNDUM WHEEL, GRAIN 80, GRADE L

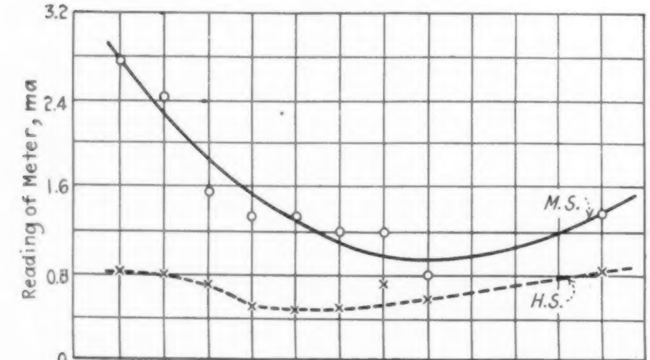


FIG. 11 RELATION OF SMOOTHNESS TO REVOLUTIONS OF WORK WITH ALUNDUM WHEEL, GRAIN 80, GRADE M

on these observations, the authors have only taken readings 20 sec after the motion of the needle has been started. After 20 sec no mark of the needle is perceived on the surface of mild steel and hardened steel. In the case of brass, marks of the needle still remain. The pressure of the needle on the surface is about 20 grams.

RESULTS OF EXPERIMENTS WITH SMOOTHNESS TESTER

The new smoothness tester was used in the following experiments on ground and turned surfaces:

Relationship Between the Duration of Grinding and Smoothness in Continuous Grinding. After dressing the grinding wheel with a diamond dresser, a round bar, approximately 40 mm in diameter and 200 mm in length, was ground continuously by it. After each grinding of 20 times, a test bar of the same material, separately prepared, was ground and the change in the state of the finished surface, according to the number of grindings was determined. Mild steel and hardened steel (Rockwell C 75) were used as test materials, and three grinding wheels of alundum were employed: Grain 100, grade unknown; grain 80, grade L; and grain 80, grade M.

Fig. 6 shows the results of the experiment made on the grinding wheel of grain 100. We find that the smoothness is poor immediately after the dressing, but improves as the experiment continues. Thereafter the curve rises and falls until finally chatter marks appear. The curve indicates that, when the grinding grains become blunt the smoothness gets poor, but when the grains free themselves from the wheel, the smoothness becomes better temporarily. Then the smoothness becomes inferior again. When this operation is repeated several times, a part of the grinding grains fail to come off, even after they are worn out, and chatter marks are produced. But this phenomenon varies in relation to the type of grinding wheel, as will be described later.

This experiment shows that both mild steel and hardened steel produced chatter marks when the number of revolutions of the work was only 150 rpm. But when the number of revolutions of the work reached 350 rpm, the smoothness of both materials was good up to a ground length of 3200 cm, even though there were several rises and falls in the curve.

Fig. 7 shows the results of the experiment made on a grinding wheel of grain 80, grade L. This grinding wheel was used for the purpose of grinding hard steel, but since the results were irregular, it may be assumed that parts of the grinding wheel were not uniform in quality. In each of the four cases shown on the chart, a different part of the wheel was utilized after each dressing. Generally, it can be seen that the smoothness is rather inferior immediately after dressing, but after a while shows a decided improvement.

Fig. 8 shows the results of the experiment made on the grinding wheel of grain 80, grade M. This grinding wheel was used for the purpose of grinding mild steel, and in each experiment showed almost the same results. This may mean that the parts of the wheel were uniform in quality. It was observed that the smoothness was poor at the beginning as it was in the foregoing experiments, but after a while it improved. Mild steel either became poor in smoothness or produced chatter marks at a ground length of 2000 cm, and hardened steel at a ground length of 2400 cm. Therefore it may be concluded that the smoothness of mild steel is inferior to that of hardened steel by some 50 per cent.

Number of Revolutions of Work and Smoothness. In the cylindrical grinding machine, changes in smoothness resulting from changes in the number of revolutions of the work, at a fixed rate of feed, were tested.

Fig. 9 shows the results of the experiment made on the grind-

ing wheel of grain 100. The smoothness improved with an increase in the number of revolutions, but beyond a certain limit it again became inferior. This tendency is observed in all of the experiments. As shown in Fig. 9, mild steel shows up best in smoothness at 350 rpm (linear velocity 27.4 m per min), and hardened steel at 400 rpm (linear velocity 31.4 m per min). These speeds seem to be somewhat greater than those generally used.

Fig. 10 shows the results of the experiment made on the grinding wheel of grain 80, grade L. In this case, variations in smoothness were comparatively small. Both mild steel and hardened steel showed satisfactory smoothness in the neighborhood of 400–450 rpm (linear velocity 31.4–35.3 m per min), but it is apparent that hardened steel is better in smoothness.

Fig. 11 shows the results obtained from the experiment made on the grinding wheel of grain 80, grade L. In this case, mild steel showed the best smoothness at 500 rpm (linear velocity 39.3 m per min) and the hardened steel at 350 rpm (linear velocity 27.5 m per min). With hardened steel, variations in smoothness caused by the number of revolutions are small.

Relationship Between Depth of Grind and Smoothness. Taking the depth to be ground each time as 2, 4, 6, 8, and 10 μ (microns), the variation in smoothness in each of these cases was determined.

Fig. 12 shows the results of the test on the grinding wheel of grain 80, grade M. From this it is observed that the greater the depth ground, the poorer the smoothness. The results shown on the chart were obtained from a test on the same grinding wheel after dressing. Comparing the smoothness of mild steel with that of hardened steel, it is seen that the former is inferior to the latter, the deflection of the milliammeter in the first being 1.50 and 1.08 for the hardened steel.

Diameters of Round Bars to Be Ground and Smoothness. Round bars, 10, 20, 30, 40, and 50 mm in diameter, were ground with the same grinding wheel under the same conditions, at the same rate of feed, and at the same circumferential velocity (2.3 m per min) of the work, and the variations in smoothness of each bar tested.

Fig. 13 shows the results obtained from the grinding wheel of grain 80, grade M. From this, it can be seen that smoothness becomes inferior with an increase in the length of the arc in contact with the grinding wheel, resulting from an increase in diameter; but the variation in smoothness is insignificant if the variations in diameter can be limited to the extent of the experiments.

Smoothness of Finish by Turning. The second and third experiments described were also carried out with a view of determining the degree of finish by turning. Using a finishing tool and varying the feed at 0.2, 0.4, 0.6, 0.8, and 1.0 mm per revolution, the conditions of finish of the surface were determined for mild steel and brass.

Finish by turning shows considerable differences in results depending on the position of the tool and the workmanship in finishing. The finish in the experiment was an average one. Accordingly, by using the smoothness tester, the smoothness on the turned surface was found to be extremely inferior, as shown in Fig. 14. The best smoothness obtained on brass was 4.05 ma and that on mild steel being 5.88 ma. Comparing these results with those of 1.0 ma obtained by grinding, it can be seen that it is 4 to 5 times greater. Smoothness becomes worse when there is an increase in the feed of the turning tool.

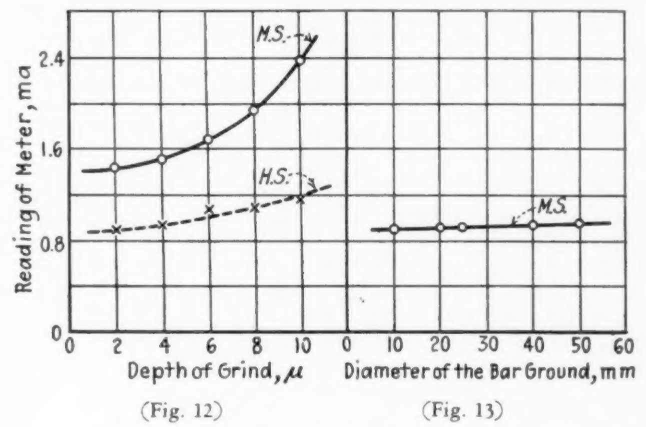
For brass, experiments were made at cutting speeds of 5 m per min and 13 m per min, the lower speed giving a better result than the higher one.

CONCLUSION

Judging from the results of the foregoing experiments made with the smoothness tester which utilizes the piezoelectrical phenomenon the authors believe that the smoothness tester of this type is useful in determining surface quality in practical work as well as in experiments. It is especially sensitive for the measurement of the smoothness of a ground surface because of its ability to discern differences which cannot be detected with the naked eye. The authors intend to carry out further experiments with this smoothness tester in the future.

ACKNOWLEDGMENT

In conclusion, the authors wish to express their thanks to Seiichi Yamamoto and Kenji Suzuki, who cooperated in the present study. Further, the authors wish to add that the present study was made possible through a subsidy granted to them by the Nippon Science Encouragement Society.



(Fig. 12) (Fig. 13)

FIG. 12 RELATION OF SMOOTHNESS TO DEPTH GROUND (μ), ALUNDUM WHEEL, GRAIN 80, GRADE M

FIG. 13 RELATION OF SMOOTHNESS TO DIAMETER OF GROUND BAR, ALUNDUM WHEEL, GRAIN 80, GRADE M

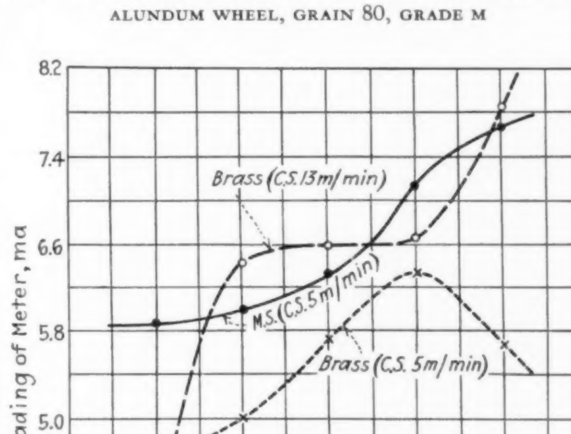


FIG. 14 RELATION OF SMOOTHNESS TO TURNING AT VARIOUS FEEDS

THE V.D.I. STEAM TABLES

By JOSEPH H. KEENAN

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

THE Verein deutscher Ingenieure recently published the V.D.I.-Wasserdampftafeln[1] (V.D.I. steam tables), which were prepared by We. Koch, director of the heat laboratories of the Physikalisch-Technischen Reichsanstalt. Dr. Koch has contributed valuable experimental work, primarily measurements of specific heat, to the field of steam research. His first contributions were made in collaboration with Dr. Oscar Knoblauch at the Technische Hochschule in Munich. Subsequently he was in charge of steam research at Munich before transferring to his present position in the Reichsanstalt.

In a foreword to the V.D.I. steam tables, dated March, 1937, Koch calls attention to two previous German steam tables, namely, those of Mollier and of Knoblauch, Raisch, Hausen, and Koch. He states that recent advances in the knowledge of the properties of steam have made it fitting and necessary that from these should grow a single new table.

Koch's tables were prepared from the "accepted values" of the last International Steam Tables Conference[2] which was held in the United States in September, 1934. The current American Steam Tables,[3] on the other hand, were based on material selected by its authors from the entire list of available research data. The basis of the Koch tables is thus a compromise between the opinions of competent investigators in Europe and America; one of these opinions is the basis of the American Tables.

The pressure-volume-temperature relation corresponding to the International Skeleton Tables was stated by Koch in an equation with only six constants (if all coefficients and exponents are included in the reckoning, except the gas constant and the numerals 1 and 2). The simplicity of the equation is commendable even though it does not fit the Skeleton Table data over the entire range. At high pressure near saturation it is supplemented by a graphic development in accordance with the practice followed in all recent steam tables. Since no description is given of the boundaries within which the equation is valid, it cannot easily be compared with previously published ones.

The pressure-volume-temperature equation is transformed in accordance with the laws of thermodynamics to give expressions for enthalpy and entropy. Following the usual procedure, the author selects the enthalpy at zero pressure as the arbitrary function of integration, and the values of this function are established to agree with the saturation values of the International Skeleton Table. Further evidence of the validity of the Skeleton Table values in the superheat region may be drawn from their excellent agreement with Koch's equation.

The Koch tables are more convenient than any steam tables previously published in Europe. For instance, they include three times the number of saturation states and more than five times the number of single-phase states appearing in the earlier German tables. America may "point with pride" to the sagac-

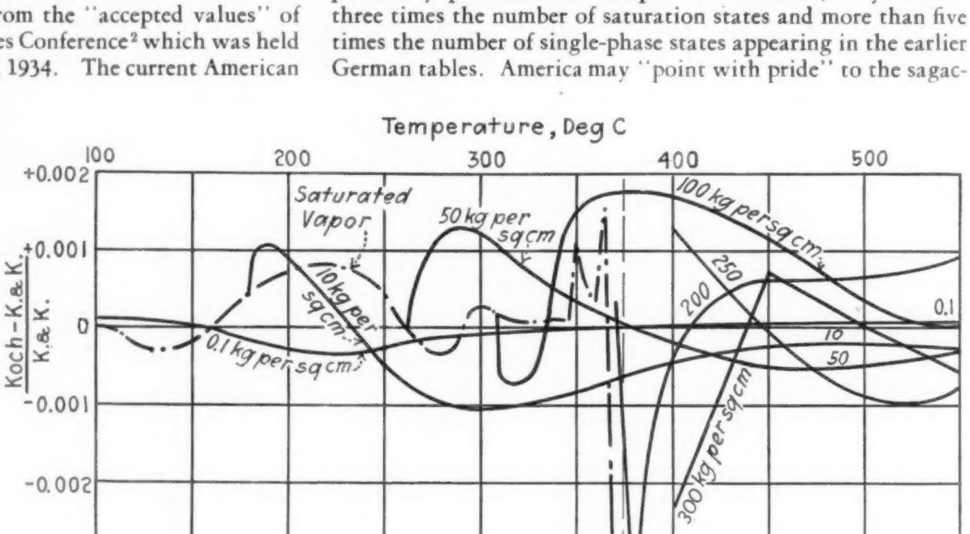


FIG. 1 COMPARISON OF VAPOR SPECIFIC VOLUMES FROM KOCH AND FROM KEENAN AND KEYES

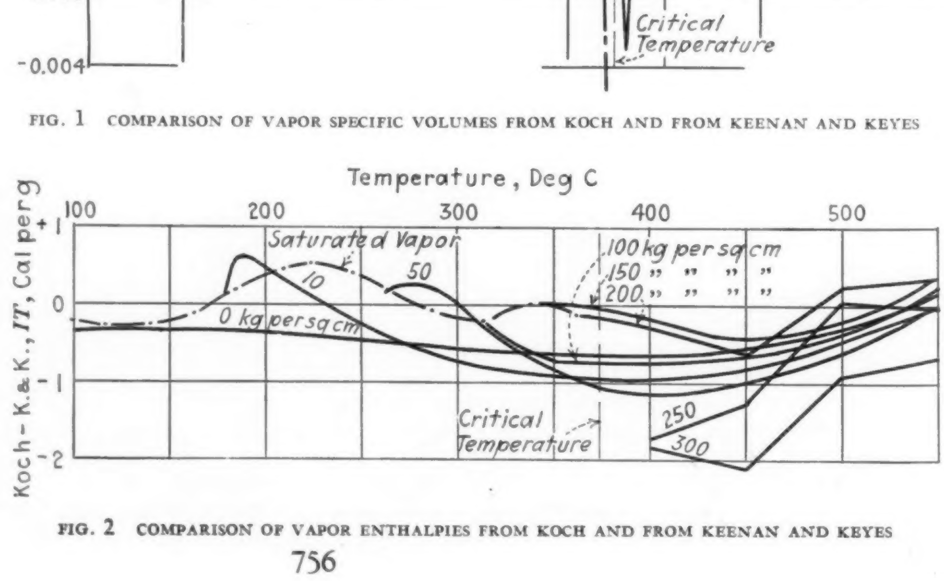


FIG. 2 COMPARISON OF VAPOR ENTHALPIES FROM KOCH AND FROM KEENAN AND KEYES

[1] "VDI-Wasserdampftafeln," by We. Koch, R. Oldenbourg, Munich and Berlin, and J. Springer, Berlin, 1937.

[2] "The Third International Conference on Steam Tables," MECHANICAL ENGINEERING, vol. 57, 1935, pp. 710–713.

[3] "Thermodynamic Properties of Steam," by J. H. Keenan and F. G. Keyes, John Wiley and Sons, Inc., New York, N. Y., 1936.

ity of Cecil H. Peabody who originated the convenient steam table and made it current in America. For some strange reason Europe has been content until today with awkward abbreviations.

There are the usual pair of saturation tables having respectively temperature and pressure as arguments, and giving, in addition to these, specific volumes of liquid and vapor, density of vapor, enthalpy of liquid and vapor, change in enthalpy (latent heat), and entropy of liquid and vapor. The single-phase table is arranged in columns of constant pressure and lines of constant temperature. It covers in a single table the compressed-liquid and superheated-vapor regions. Since values are given for every 10 C, a large amount of space is devoted to the compressed liquid. In the Keenan and Keyes tables[3] the compressed liquid was covered by a small auxiliary table giving differences between the values of each property at a given state and at the saturation state for the same temperature. Now the two arrangements can be compared in practice.

TABLE 1 COMPARISON OF ISENTROPIC ENTHALPY DROPS FROM KOCH[1] AND FROM KEENAN AND KEYES[3]

Initial pressure:		
Kg per sq cm	100.0	25.0
Lb per sq in	1422.3	355.6
Initial temperature:		
Centigrade	400	500
Fahrenheit	752	932
Initial entropy:		
Koch	1.4865	1.7497
Keenan and Keyes	1.4875	1.7507
Initial difference in enthalpy,[a] per cent	—0.100	—0.067
Difference between enthalpy drops,[a] per cent, at the following pressure ratios:		
0.6000	—0.06	—0.10
0.4000	—0.20	—0.13
0.2000	—0.18	—0.06
0.1000	—0.18	—0.09
0.0100	—0.11	—0.13
0.0010	—0.14	—0.08
0.0001	—0.14	....
Average	—0.14	—0.10

[a] Calculated from the formula: [(Koch — K. & K.)/K. & K.] 100, wherein Koch's values were taken from the reference in footnote 1 and Keenan and Keyes values were taken from the reference in footnote 3.

The energy unit employed by Koch is the IT. calorie which was adopted by the First International Steam Tables Conference at the suggestion of Max Jakob[4] who preceded Dr. Koch as director of the heat laboratories of the Reichsanstalt. Dr. Jakob's proposal was to define the calorie in terms of an international electrical unit, the watthour, instead of in terms of the properties of water. On page 27 of the Keenan and Keyes tables[3] a footnote states that "The Btu (of those tables) is derived from the IT. calorie through the relation 1 IT. cal per g = 1.8 Btu per lb." Here is an object lesson in the value of Dr. Jakob's contribution—for the first time in the history of steam tables two have appeared that are based on the same energy unit.

Koch employs the term "enthalpie" to denote the sum of the internal energy and the pressure-volume product, although with its first appearance he includes a parenthetic "Wärmeinhalt." The equivalent term "enthalpy" is employed in the current American tables and is in accord with the recommendation of the Council of the A.S.M.E.[5]

A less fortunate choice is the abbreviation "at" for the pressure unit, kilogram per square centimeter. In the list of symbols is the statement "*p* Druck in kg per sq cm (at)," which helps to avoid confusion but fails to eliminate the difficulty. Certainly the slight gain in brevity when "at" is substituted for "kg per sq cm" does not justify using throughout the tables a symbol which can be interpreted as denoting the international atmosphere.

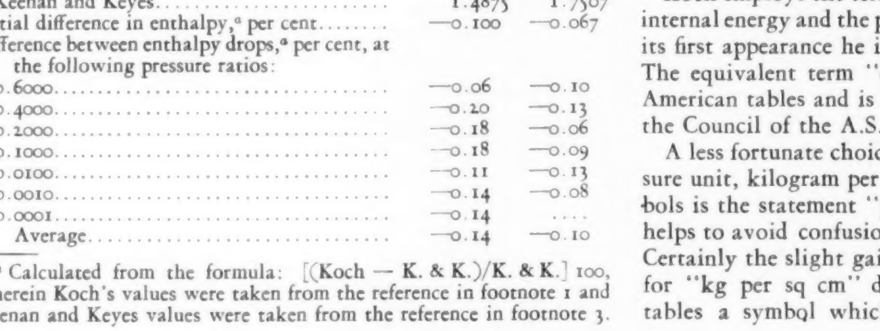


FIG. 3 COMPARISON OF LIQUID SPECIFIC VOLUMES FROM KOCH AND FROM KEENAN AND KEYES

In Figs. 1 to 4 and in Table 1 are shown comparisons between the V.D.I. tables and the current American tables. The differences are in general so small that they must be shown to a scale larger than is justified by the precision of interpolation. Therefore, there are some lines, notably those passing close to the critical point, for which the curvature is indeterminate. These have been indicated by straight lines joining computed points. In each of the four charts the entire band of values, representing both tables, lie within the tolerances established by the Third International Steam Tables Conference. It is largely owing to the accomplishments of this conference and of those that preceded it, that corresponding values from the two tables agree in general within one part in a thousand.

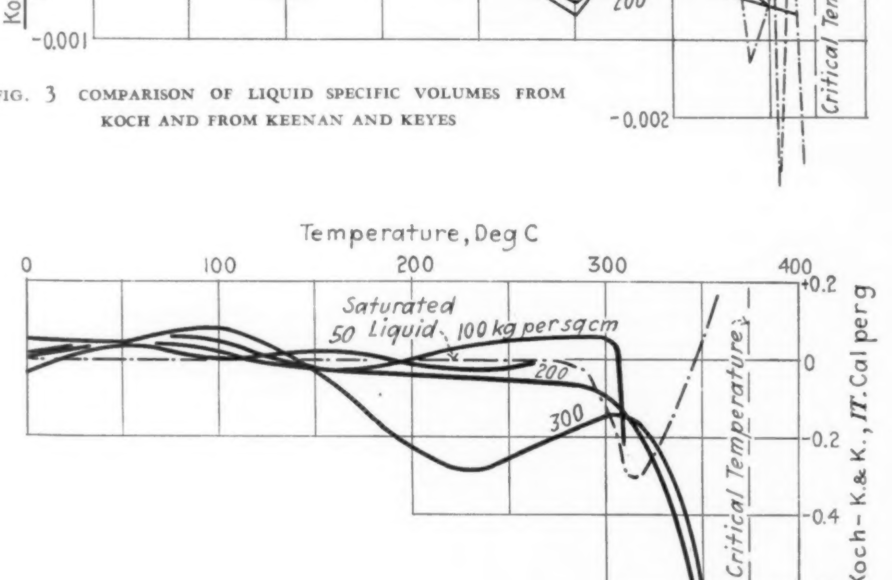


FIG. 4 COMPARISON OF LIQUID ENTHALPIES FROM KOCH AND FROM KEENAN AND KEYES

[4] Now Director of Research, Armour Institute of Technology, Chicago, Ill.

[5] "Use of Term 'Enthalpy' Recommended," Mechanical Engineering, vol. 58, 1936, p. 532.

A.S.M.E. HONORS AND AWARDS

I—Jointly Sponsored With Other Organizations

RECOGNITION of the engineer's work through the bestowal upon him of a suitable award or medal by his fellow engineers is the greatest honor which can be attained by him for his accomplishments. Whether he be only an engineering student, junior engineer, chief engineer, educator, or executive, there is before him an incentive for meritorious achievement in the many awards which have been established by various engineering organizations. Among those for which mechanical engineers are eligible, are several under the joint sponsorship of The American Society of Mechanical Engineers and one or more other engineering societies or groups in the United States and other countries.

Acting upon the nominations of the Board of Honors and Awards, the Council appoints such number of members to represent the Society on joint boards of awards as may be required by the by-laws of those bodies. The joint bodies are: John Fritz Medal Board of Award, Hoover Medal Board of Award, Washington Award Commission of the Western Society of Engineers, Gantt Medal Board of Award, Daniel Guggenheim Medal Fund, Inc., Committee of Award for the Alfred Noble Prize, and the Marston Medal Board of Award.

JOHN FRITZ MEDAL

One of the most important engineering awards in this country is the John Fritz Medal established by the professional associates and friends of John Fritz to perpetuate his memory and his accomplishments in industrial progress. The fund is administered jointly by the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, and the American Institute of Electrical Engineers through United Engineering Trustees, Inc. The medal is awarded annually by the John Fritz Medal Board of Award for notable scientific or industrial achievement without restriction as to nationality or sex. It was first awarded on Aug. 21, 1902, to John Fritz at a dinner tendered to him on his eightieth birthday. Among the 33 engineers and scientists who have been recipients of the Medal are Lord Kelvin, George Westinghouse, Alexander Graham Bell, Thomas A. Edison, John E. Sweet, Elihu Thomson, George W. Goethals, Guglielmo Marconi, Ambrose Swasey, Elmer A. Sperry, Herbert Hoover, Michael I. Pupin, John R. Freeman, and William F. Durand.

THE HOOVER MEDAL

The Hoover Gold Medal was formally instituted on April 8, 1930, during the celebration of the fiftieth anniversary of The American Society of Mechanical Engineers, to commemorate the civic and humanitarian achievements of Herbert Hoover and to whom the first award was made. The trust fund creating the award is the gift of Conrad N. Lauer, past-president of the Society. It is held by The American Society of Mechanical Engineers and administered by a Board of Award consisting of representatives of the four Founder Societies. The second award was made to Ambrose Swasey in 1936.

WASHINGTON AWARD

The Washington Award was founded in 1916 by John Watson Alvord "in recognition of devoted, unselfish, and preeminent service in advancing human progress." It is administered by the Western Society of Engineers on recommendation of a commission representing the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the Western Society of Engineers.

The first award was made to Herbert Hoover in 1919. Other distinguished engineers who have been recipients include Orville Wright, Mortimer E. Cooley, Ambrose Swasey, and C. F. Kettering.

THE GANTT MEDAL

To memorialize the distinguished achievements and great service to the community rendered by Henry Laurence Gantt, management and industrial engineer and leader in industry, an award known as The Gantt Medal was established in 1929 by his friends to be given for "distinguished achievement in industrial management as a service to the community." The award is administered by the Institute of Management, a research group of the American Management Association. Selection of recipients is made by a board made up of representatives of the Institute of Management and The American Society of Mechanical Engineers. The first award of the gold medal was made posthumously to Mr. Gantt. Others who have been honored with this award are Fred J. Miller, past-president, A.S.M.E., L. P. Alford, past vice-president, A.S.M.E., Wallace Clark, member, A.S.M.E., and Horace Cheney.

The first of a series of articles, prepared under the direction of the Board of Honors and Awards of The American Society of Mechanical Engineers, better to acquaint the members of the Society concerning the honors and awards which are given in recognition of meritorious achievements of engineers.

THE GUGGENHEIM MEDAL

The Daniel Guggenheim Medal was created for the purpose of honoring persons for notable achievements in the advancement of aeronautics. Provision for the gold medal, to be awarded annually, was made in 1928 by the gift of an endowment from the Daniel Guggenheim Fund for the Promotion of Aeronautics. To receive and administer this fund, there has been created a corporation made up of members of The American Society of Mechanical Engineers, the Society of Automotive Engineers, and the Institute of the Aeronautical Sciences. The Board of Award is international in its membership, having representatives on it not only from the aforementioned engineering bodies but one member each from Canada, England, France, Germany, Holland, Italy, and Japan. The first recipient of the Medal was Orville Wright in 1929. Other recipients include many world-famous engineers.

THE NOBLE PRIZE

The Alfred Noble Prize was established in 1929 and consists of an annual award of $500 in cash from the income of a fund contributed by engineers and others in honor of the late Alfred Noble, past-president of both the American Society of Civil Engineers and the Western Society of Engineers. The award may be made to a member of any grade of either the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, the American Institute of Electrical Engineers, or the Western Society of Engineers, for a technical paper of particular merit, provided that the author at the time the paper is accepted for presentation or publication is not over 30 years of age. The recipient of the prize is selected by a committee of five, consisting of one representative from each society.

PI TAU SIGMA AWARD

The Pi Tau Sigma Award was established in 1938 by the honorary engineering fraternity, Pi Tau Sigma, as a suitable means of recognizing the accomplishments of outstanding young mechanical engineers. Achievement may be all or in part in any field, including the industrial, educational, political, research, civic, and artistic. Any young man, who on June 1 of each year has been graduated not more than ten years from the regular mechanical-engineering course of a recognized American college or university, and is not more than 35 years of age, is eligible to be nominated for the annual award by local sections of The American Society of Mechanical Engineers, engineering schools, Pi Tau Sigma members, and other qualified individuals.

On or before June 1 of each year, the Pi Tau Sigma Award Committee examines the nominations which have been received and selects ten young engineers who, in its opinion, are the most outstanding. The names of these men, together with the information received about each one, are submitted to the Board of Honors and Awards of The American Society of Mechanical Engineers for the final selection of the most outstanding young mechanical engineer for that year. The selected recipient receives an honorarium to cover his travel expenses to and from the Annual Meeting of The American Society of Mechanical Engineers where he is presented with the Pi Tau Sigma gold medal.

THE MARSTON MEDAL

The Marston Medal was established by Iowa State College through the inspiration and generosity of Anson Marston who was professor of civil engineering from 1892 to 1920, dean of engineering from 1904 to 1932, and dean emeritus at the time the award was established in 1938. The medal is an honor to be conferred annually upon an engineering alumnus of Iowa State College in recognition of achievement in engineering. In this connection engineering is broadly interpreted to include teaching, research, or activity in behalf of any national engineering society. The recipient is selected by a board of award of nine persons, consisting of four alumni, one representative each from the American Society of Civil Engineers, The American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the American Institute of Chemical Engineers, and the dean of engineering of Iowa State College.

INTERNATIONAL AWARDS

The Kelvin Gold Medal, which is presented triennially as a mark of distinction in engineering work or investigation of the kinds with which Lord Kelvin was especially identified, was established through the efforts of Calvin W. Rice, secretary of the A.S.M.E., 1906–1934.

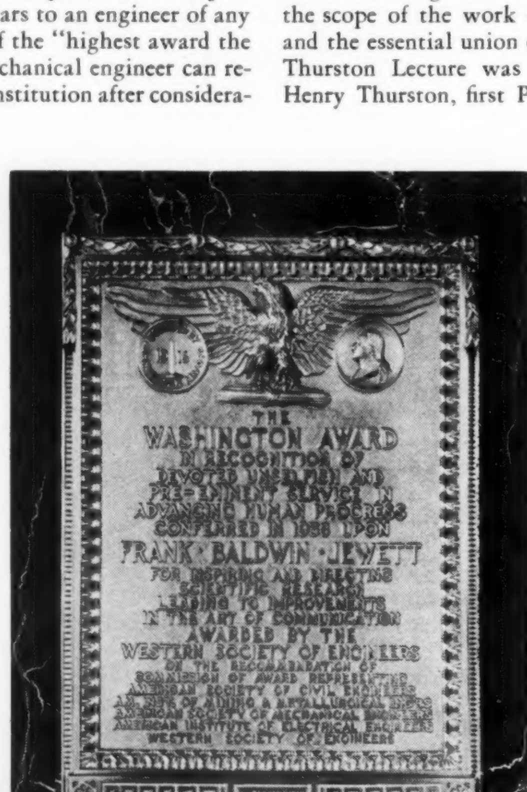
In 1910 the A.S.M.E. made a visit to the Institution of Mechanical Engineers at its Birmingham meeting. While in London, Dr. Rice and other members visited Westminster Abbey for special services in honor of Benjamin Baker, honorary member, A.S.M.E. Dr. Rice noticed that every window in the entire Abbey, save one, was a memorial window. The next day he called on the Dean and in conversation commented on the unoccupied window. The Dean immediately responded that the Abbey would appreciate a gift of a memorial window. Dr. Rice thereupon sensed the situation and offered a window, knowing it would be an easy matter to collect from the entire English-speaking world an amount sufficient to install a window to an engineer.

Dr. Rice proposed a window to Lord Kelvin as one mutually desired by the Abbey and by engineers. Consistently, he arranged that this memorial be provided through the cooperation of the engineering bodies of Great Britain and the United States. When the undertaking was assured, he placed the whole proposition in the hands of the Institution of Civil Engineers, the oldest engineering organization in the world, for announcement of the popular subscription.

The result was so successful that not only was the window provided but the Kelvin Medal was founded and awarded for

the first time in 1920. The award is made by a committee of presidents of the representative British engineering institutions, after considering recommendations received from similar bodies in all parts of the world, including The American Society of Mechanical Engineers. Among the distinguished recipients is found Elihu Thomson, honorary member, A.S.M.E.

The James Watt International Medal was established in 1936 by the British Institution of Mechanical Engineers to commemorate the bicentenary of the birth of James Watt on Jan. 19, 1736. It is awarded every two years to an engineer of any nationality who is deemed worthy of the "highest award the Institution can bestow and that a mechanical engineer can receive." The award is made by the Institution after consideration of the nominations received from engineering institutions and societies throughout the world. The first recipient of the Medal was Sir John A. F. Aspinall, honorary member, A.S.M.E., who received the award posthumously in 1936. Henry Ford, member, A.S.M.E., was named as the recipient of the 1938 award after his nomination for the honor by The American Society of Mechanical Engineers.



MEMORIAL LECTURESHIPS

Another important group among the honors and awards of The American Society of Mechanical Engineers are the three memorial lectureships, which in their establishment and naming do honor to the memory of famous members of the Society. They serve also as a means of honoring world leaders in the fields of engineering, science, and economics by inviting them to present papers before the Society on phases of their particular activities.

Two of these memorial lectures, known as the Henry R. Towne Lecture and the Robert Henry Thurston Lecture, were initiated in honor of these famous mechanical engineers by the Council in 1925, and are delivered every year during the Annual Meeting of the A.S.M.E. The Towne Lecture presents the newest thought on topics in the zone between engineering and economics to perpetuate the memory of Henry R. Towne, the outstanding feature of whose career lay in the extension of the scope of the work of the engineer to include economics, and the essential union of production and management. The Thurston Lecture was founded as a tribute to Dr. Robert Henry Thurston, first President of the Society and for many years its inspirational leader. This lecture deals with subjects in the zone between engineering and science and presents the latest knowledge in the field in which Dr. Thurston was so notable a pioneer.

The third lecture in memory of Calvin W. Rice, secretary of the Society, 1906–1934, was inaugurated in December, 1934, with a talk on Dr. Rice's contributions to "International Friendliness" by Dr. John H. Finley, editor of the *New York Times*. Subsequent lectures, dedicated to the cause of furthering the international relationships of engineers, are now presented at the Semi-Annual Meetings of the Society by world-famous engineers of other countries.

Since the memorial lectures are an important feature of the national meetings of the Society, their arrangement and the selection of the lecturers are functions of the Committee on

Meetings and Program. The choice of the committee for each lecture is presented to Council for its approval and the invitation to the selected lecturer is then sent out by the President of the Society.

A.S.M.E. AWARDS

In addition to these honors, in the bestowal of which The American Society of Mechanical Engineers participates, there are several medals and awards, which are under the sole jurisdiction and administration of the Society through its Board of Honors and Awards. Before continuing with the story of the origin and recipients of each award, it is well at this point to tell of the establishment of the Board and its Committee on Medals.

In June, 1919, the Council of The American Society of Mechanical Engineers approved, in principle, certain recommendations by the Committee on Relations With Colleges, acting as a Special Committee on Awards, relating to several forms of recognition of achievement in engineering and eminence in the profession. Up to that time, comparatively little interest had been shown by the Society in recognizing, through awards, honors, and medals, the praiseworthy accomplishments of its members.

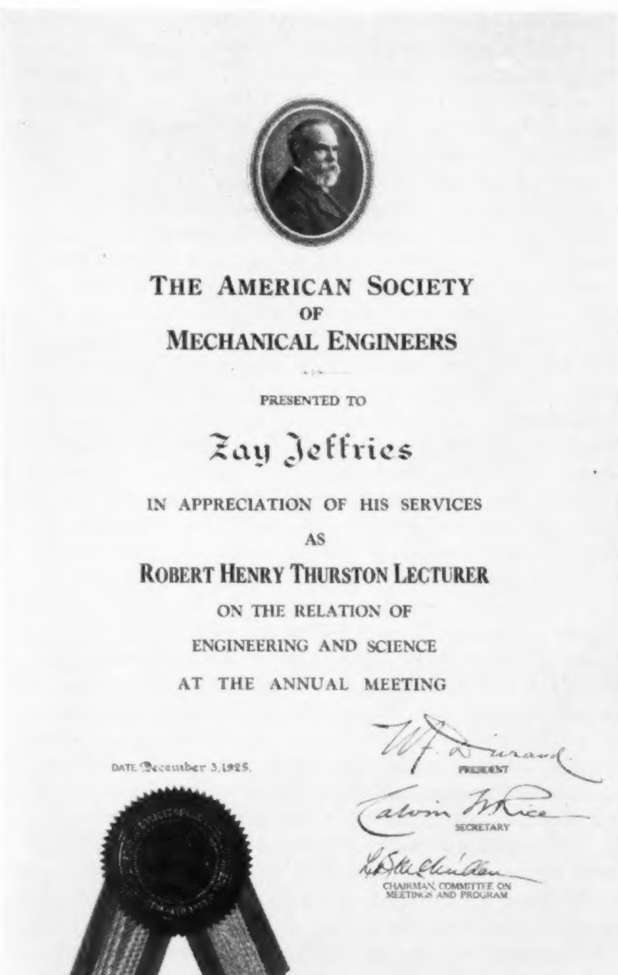
After working on the problem still further, the Special Committee on Awards under the direction of Dr. Ira N. Hollis, past-president, A.S.M.E., submitted to the Council its final recommendations which, among several others, included the suggestion that a permanent Committee of Awards be established. These recommendations were approved on Oct. 15, 1920, marking the beginning of the development of the policy now governing the numerous honors within the bestowal of the Society.

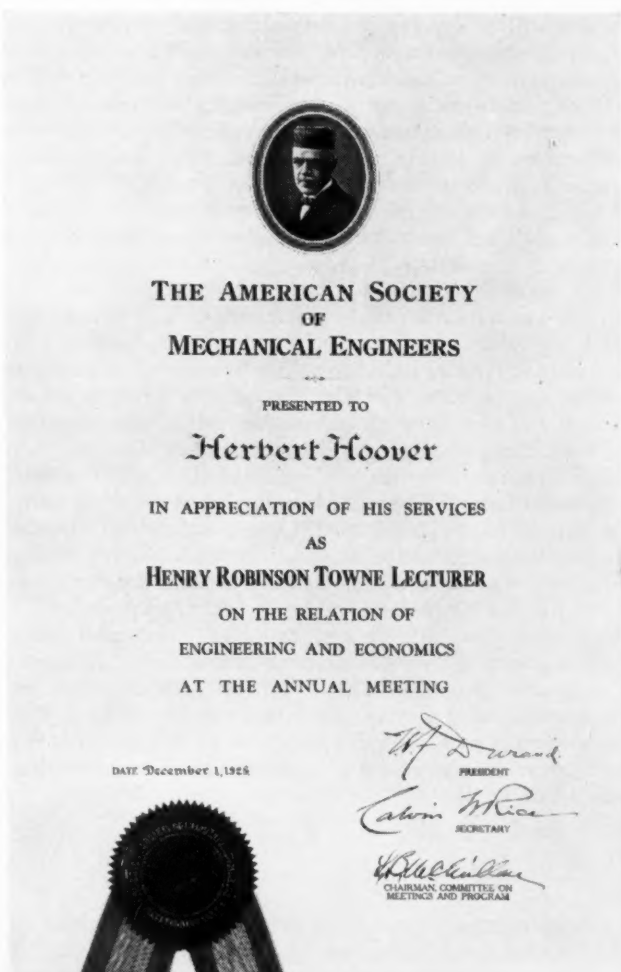
BOARD OF HONORS AND AWARDS

In 1935, the Committee on Awards, which was appointed to consider all matters connected with prizes, awards, and special recognition, and to make definite reports to the Council, was redesignated the Board of Honors and Awards. The Board consists of five members, and under the Society's rules one member retires every year and a new one is appointed to serve a five-year term. It nominates recipients for the various awards to the Council, and in addition, makes nominations for A.S.M.E. representatives on boards administering jointly sponsored awards.

COMMITTEE ON MEDALS

Associated with the five members of the Board of Honors and Awards are fifteen other persons, appointed in groups of three, for five-year terms. This body of twenty engineers constitutes the Society's Committee on Medals, which is a subcommittee of the Board. It is the duty of the committee to make nominations to the Board for the A.S.M.E. Medal, the Holley Medal, and the Warner Medal, which are solely administered by The American Society of Mechanical Engineers.





BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context, and credit to original sources is given.

Day by Day

AUGUST, widely publicized as the critical month, passed without witnessing the outbreak of a general war in Europe, although the tension of apprehension tightened, and, as this is being written, events are in progress that will lead either to open conflict or a relaxation of immediate fears. The entire world is so definitely concerned that the progress of engineering is being conditioned by what is now transpiring. The efforts of scientists and engineers are being directed toward preparations for defense. Industrial policies, as in the case of the 40-hour week in France, are being modified by the threat of future events. Notably in Germany, efforts at self-sufficiency are resulting in *ersatz* materials. Switzerland is discussing ways of storing foodstuffs and essential commodities against the day when her imports may suffer interference or stoppage. The unemployment slack is being taken up in many countries by feverish production, largely of war material. But be it peace or war, science and technology continue in demand.

Again and again, as plowshares and pruning hooks are beaten into swords and spears, science is blamed for inventing new horrors of destruction. Men of science, who do so much for peace, resent this criticism. Even at the recent meeting of the British Association for the Advancement of Science, Lord Rayleigh appended to his presidential address, which was devoted to "vision in nature and vision aided by science," a section on "science and warfare," in which he pointed to many notable examples of new materials and machines, that were developed without thought of war or destruction, but that have been seized upon by the warmakers because of their effectiveness in defense or offense. The condition complained about, he shows, antedates the age of science and is as old as the arts themselves. Every advance in technology and materials has provided as many opportunities and posed as many problems for the militarists as it has for peaceful society. Summing up, he says, "I think we may say that the application of fundamental discoveries in science to purposes of war is altogether too remote for it to be possible to control such discoveries at the source. . . . . The world is ready to accept the gifts of science, and to use them for its own purposes. It is difficult to see any sign that it is ready to accept the advice of scientific men as to what those uses should be."

B.A.A.S.

Among noteworthy results of the meeting of the British Association for the Advancement of Science at Cambridge, England, August 17 to 24, were the agreement reached on first steps to be taken in an Anglo-American accord for the social interpretation of science, and the establishment of a division within the association "for the study of the social relations of science, which will attempt to bring the steady light of scientific truth to bear on vexed questions," as Lord Rayleigh put it in the concluding paragraph of his presidential address. Some features of the suggested cooperation between the B.A.A.S., and its sister organization in this country, the American Association for the Advancement of Science, are the proposals that each association invite annually distinguished members of the other to deliver lectures addressed both to scientists and to laymen in an endeavor to explain what science and technology are doing; that both associations established collateral honorary memberships; and that arrangements be made for the interchange of essential information. Specifically, it was decided that representatives of the British Association will attend the 1939 summer meeting of the A.A.A.S.

It remains for the American Association for the Advancement of Science to act upon the proposals, but it is safe to forecast favorable action when it is recalled that international cooperation between scientific bodies was proposed in a resolution adopted at last winter's Indianapolis meeting of the A.A.A.S., as reported on page 156 of our issue for February, 1938. Further evidence is to be found in the fact that the representatives of the A.A.A.S. in attendance at Cambridge were George D. Birkhoff, retiring president of the A.A.A.S., and F. R. Moulton, its permanent secretary.

From dispatches to the *New York Times* from one of that newspaper's editors, Waldemar Kaempffert, member, A.S.M.E., in attendance at the Cambridge meeting, it is apparent that conservative members of the British association hesitated to take steps at this time looking toward a world association of scientific bodies "in defense of freedom of thought," although it is reported that "such an association may well grow out of the new relationship." It will be recalled that the A.A.A.S. Indianapolis resolution invited the British Association for the Advancement of Science and "all other organizations with similar aims throughout the world . . . . . to cooperate not only in advancing the interests of science, but also in promoting peace among nations and intellectual freedom in order that science may continue to advance and to spread more abundantly its benefits to all mankind."

A vigorous and outspoken expression of the views held by one section at least of American scientists appeared in the August 20 issue of *Science News Letter*, organ of Science Service, Inc., to which the A.A.A.S. nominates trustees. Watson Davis, director of Science Service, Inc., and editor of *Science News Letter*, in an article "Scientists, Unite!" stated that the most important problem before the scientific world today is, How can science maintain its freedom and how can it help preserve a peaceful and effective civilization? He recalled the A.A.A.S. resolution of 1933 which contained the statement, "We regard the suppression of independent thought and of its free expression as a major crime against civilization itself," referred to the anticipated cooperation between the A.A.A.S. and the B.A.A.S. at the Cambridge meeting as the "latest effort to bring scientists of different nations into mutual endeavor," and pointed out that "there are areas upon the earth where science is being per-

verted and distorted to serve compulsion and repression." And later, following an assertion that "democracy is the child of science," he added, "If the great scientific 'push' is to be successful, there will need to be more and freer discussion than has been traditional. Whether the new science movement takes the form of a great intellectual brotherhood, a new political party, or an infiltration into existing progressive movements, it must be articulate, self-assertive, and combative within the limits of the scientific method. It must become a crusade with truth as its only dogma."

A British point of view on the important question of the preservation of the right to engage in research was expressed in a recent editorial in *Nature*. The editorial said in part:

"Science will only be reestablished in its unique place among the interests of mankind when scientific workers everywhere recognize their responsibilities and are prepared to make fresh sacrifices in the cause of intellectual freedom. They must educate their fellow citizens to the realization that science is a common interest of mankind, and that whatever may be the barriers or the difficulties or the struggles between them, civilized societies must accord a certain immunity and tolerance to those engaged in scientific discovery and learning.

"Besides this, there must be a widespread recognition by scientific workers of the normal conditions of tolerance and immunity for scientific pursuits in a civilized state. These restraints—not to meddle with or be dominated by divinity, morals, politics, or rhetoric—must be clearly understood and firmly accepted by scientific workers. The loyal acceptance of such a code of ethics or discipline is all the more important today, not only if objective research in the social sciences is to be pursued, but also if what is often termed the frustration of science is to be overcome."

Further evidence of the concern with which the "impact of science on society" is viewed and the reasons for giving more attention to this phase of scientific developments, is found in a portion of the remarks addressed to the 1500 members of the B.A.A.S. by the Right Rev. C. F. Garbett, Bishop of Winchester, at Great St. Mary's Church on Sunday, August 20. He is reported to have said in part: "The truth is that the man who has learned to conquer the world has not learned to conquer himself. His advance in character has not kept pace with his advance in knowledge. His intellectual and technical development has far outstripped his moral progress."

Recovery

In contrast to these evidences of apparent social disintegration, it is pleasant to note the trend of economic recovery in this country, as indicated by stock-market quotations and production indexes that are hopefully hailed as a promise of better times. Advance publicity for the coming announcements of 1939 automobiles notes that the stock of used cars has been reduced to manageable proportions, that the number of 1938 cars to be carried over is gratifyingly small, that plans for the new models are under way with some makes already in production, and that much money is being spent on materials and tools.

According to an article in the *Wall Street Journal*, reports from 37 states east of the Rockies show that contracts for new housing placed in July, 1938, were 8.5 per cent greater than in July, 1937. The article also quotes the Department of Labor report to the effect that permits for home building in July, 1938, were up 128.8 per cent over July, 1937. Employment gained contraseasonally in July, carloadings increased, steel production advanced, and the curves of industrial production showed upward tendencies. Commenting on indications of recovery, the September newsletter of the National City Bank, New York, states that "the improvement has gone far enough to indicate that the turn is real, but not far enough to run into a natural setback."

Labor

Labor continued to hold its own in the spotlight. Experience with the operations of the Wagner Act has brought dissatisfaction to many if not most employers, who have not failed to point out what to them appears to be the one-sidedness of the law and its enforcement, and also to one faction, at least, of labor. It becomes increasingly evident that the law is not a final solution to labor troubles, and the chances that it may be critically examined in the light of experiences in the settlement of labor disputes in other countries have been enhanced by the report of the United States Commission on Industrial Relations in Great Britain, on which were representatives of a variety of agencies interested in labor problems. The report served to bring home to the people of this country striking differences in fundamental technique in handling labor disputes in the United States and Great Britain. Most impressive of these differences, perhaps, is the contrast between the voluntary methods employed by the British and the compulsory methods established by law in this country. That neither side in Great Britain desires the intervention of government has been hailed by many commentators as evidence of an essentially democratic approach. Apprehension of the threat to labor of the heavy hand of government was expressed in a Labor-Day address of Matthew Woll, vice-president of the American Federation of Labor, who asked whether "we can go on accepting gains [from the Wagner Act] without at the same time paying a price that we shall, as a people, regret more bitterly." And in the field of railroad labor, where disputes come under a legal procedure peculiar to that field, observers are keenly watching the outcome of negotiations between the roads and the unions relating to proposed wage reductions.

Records

Out at Bonneville Salt Flats, Utah, on August 27, Capt. George E. T. Eyston drove his 7-ton "Thunderbolt" over a measured mile in both directions at an average speed of 345.49 mph. On the outward lap the speed was recorded as 347.49, and on the return, 343.51 mph. Captain Eyston's record was broken on September 15 by John Cobb, English sportsman, with a 2500-hp Railton, whose average speed over the same course was 350.20 mph. Captain Eyston recaptured the record on September 16 with an average speed of 357.5 mph.

On August 29 Maj. Alexander P. de Seversky, the airplane designer, flew from Floyd Bennett Field, New York, to Union Airport Terminal, Los Angeles, in 10 hr, 3 min, and 7 sec, setting a new East-to-West record. One stop was made at Kansas City for refueling. The 1200-hp Seversky monoplane obtained an average speed of 262 mph.

On Labor Day at the Cleveland air races, Col. Roscoe Turner took the Thompson Trophy 300-mile race with a new record of 283.419 mph.

Early in August the *Queen Mary* made the westward and eastward crossing of the Atlantic under conditions that resulted in the establishment of five new Atlantic records. Delayed by tidal conditions at Southampton on her outward voyage, the ship increased its average speed so that the crossing was made in 3 days, 21 hours, and 48 minutes, or an average of 30.99 knots,

beating the *Normandie's* best figure of 30.58 knots. On her homeward crossing the *Queen Mary* covered the 2938 miles between Ambrose Light and Bishop Rock in 3 days, 20 hours, and 42 minutes, at an average speed of 31.69 knots as compared with the *Normandie's* record, in August, 1937, of 31.20 knots. On the westbound passage the *Queen Mary* did her fastest run of 790 nautical miles between noon on August 5 and noon on August 6. The *Queen Mary*, says *Engineering*, has now the distinctions of the longest day's run, the shortest passage and highest average speed in each direction, and the fastest round voyage. It is said that the fairing of the shell-plate laps with cement, to reduce skin friction, may have aided materially in the setting of the *Queen Mary's* records.

Moore

At the forty-first annual meeting of the American Society for Testing Materials, Atlantic City, N. J., June 27 to July 1, 1938, Herbert Fisher Moore, member, A.S.M.E., research professor of theoretical and applied mechanics, University of Illinois, was awarded honorary membership. Of his professional record, a biographical sketch in the August, 1938, issue of the A.S.T.M. *Bulletin* says, in part: "Most of his time at Illinois has been devoted to the properties of materials and in methods of testing. He is known internationally for his extensive work on fatigue of metals and in recent years he has conducted an elaborate investigation of failures of railroad rails. He has designed various testing machines and apparatus for measuring strains. His tests have covered a wide range of materials as well as structural and machine parts."

Honorary memberships in A.S.T.M. were also conferred on F. O. Clements, technical director of the research laboratories, General Motors Corporation, and W. K. Hatt, professor of civil engineering and director of the laboratory for testing materials, Purdue University.

ZMC-2

With popular support for the lighter-than-air craft at a low ebb, it is appropriate not to let the passing of the ninth anniversary flight of the U. S. Navy's metalclad airship ZMC-2 pass without comment. The ZMC-2 is the oldest lighter-than-air craft in the world still doing regular flying. On August 19, 1938, with Lieut. Com. C. V. S. Knox, who piloted the trial flight on August 19, 1929, at the controls, the ZMC-2 celebrated its ninth birthday. The occasion appeared to call for more comment than the brief mention it received in the newspapers, and letters were therefore written to Commander Knox and to Carl B. Fritsche, member, A.S.M.E. and president, Metalclad Airship Corporation, builders of the "tin bubble," as it is affectionately called, asking for further information. Commander Knox wrote that comment would more properly come from others than from him, but Mr. Fritsche replied with a challenge to the implied question, "Why has not the airship made greater progress?" Incidentally, he reported that a small nucleus of the "Metalclad" engineering group has been kept together and that the year 1938 marks the seventeenth year of continuous association of the original group. In the December, 1929, issue of MECHANICAL ENGINEERING, Mr. Fritsche described the metalclad ZMC-2 and its unique metalclad construction.

Although it ran to greater length than had been anticipated, Mr. Fritsche's challenging reply should be made public for the sake of the record. He wrote:

Airships have not made greater progress for the simple reason that the airship fraternity has not been sufficiently audacious in its demand for higher speeds and for a greater share of the public funds annually appropriated for airship development generally. While the airplane year by year has been increasing its speed and its performance in accelerated fashion, the airship has continued to lumber along at a speed ranging between 75 to 85 mph. No wonder, therefore, it has failed to capture the public imagination and simultaneously the public confidence on which one must depend for adequate financial support.

Meanwhile, the airplane has increased its speed, its range, and its performance in remarkable fashion. This accomplishment has its genesis in three sources of progress:

1 Intensive research in aerodynamics resulting in improved design and great reduction in drag.

2 Improvement in power-plant performance, due to the employment of better alloys, improved design, variable-pitch propellers, and more efficient fuels.

3 The abandonment of fabrics in construction and the substitution of all-metal construction utilizing the most modern alloys available.

All three of these progressive developments are ready and waiting to be applied to the airship but they cannot be utilized to full advantage until those occupying positions of authority display the same audacious courage as that of their contemporaries in the airplane field and abandon orthodox methods of construction in which the hull of an airship consists of metal frame members, tied together by multitudinous wires and the whole assembly covered with doped, long-fiber cotton fabric.

In order to compete with the airplane and the flying boat in transatlantic service, and to reinspire public interest and confidence, airship proponents must set as their immediate goal a top speed of 150 mph, and a cruising speed of 120 mph. This requires all-metal construction, fundamentally similar to that employed in the metalclad ZMC-2. In fact, a fabric-covered airship cannot be built strong enough to fly 150 mph, and still carry a decent pay load.

The progress made in aerodynamic research and already applied to the airplane is likewise available to the airship designer. But to use it effectively one must resort to all-metal construction.

Likewise the improved power plants with which airplanes are now equipped are available to the airship, but at the higher speed herein proposed, the heavier, slow-speed, liquid-cooled engines are no longer necessary. On the contrary, at the increased speeds proposed, the highly efficient, lightweight, air-cooled power plants can be employed with equal efficiency. But in order to employ air-cooled engines efficiently, the airship must fly at the higher speeds proposed, which in turn requires one to resort to all-metal construction.

The modern alloys employed in all-metal construction of airplanes are likewise available to the airship and their use is mandatory if the airship is to accommodate the increased stresses resulting from such higher speeds, which again makes it mandatory that one resort to all-metal construction.

For a development program, one is disposed to recommend the construction of a metal-clad airship having a gas volume of about 1,500,000 cu ft, top speed 150 mph, cruising speed 120 mph, equipped with a nacelle keel so designed as to enable the airship to land on any protected harbor in the world with its own crew, take on water ballast through submarine valves located in the keel, thus making it statically heavy, and taxi up to a floating stub mast for mooring purposes.

It is true that a ship of this size would not carry any substantial pay load, but it would point the way how to build and operate larger and more efficient ships which would follow thereafter. It must be remembered that the 21-passenger all-metal commercial airplanes operating today had their genesis in the much smaller all-metal Ford trimotor and Lockheed airplanes.

At a cruising speed of 120 mph (allowing for a 20-mile head wind) the commercial-size metalclad airship would be able to negotiate a nonstop transatlantic voyage in 36 hr and at considerably less cost per passenger-mile than the expense of operating a large airplane having a gross weight of 100,000 lb over the same distance.

This airship flight time compares favorably with the forecast made by Jerome C. Hunsaker of the performance of future transatlantic airplanes. In a technical paper presented last year before the Lilienthal Society in Germany, Dr. Hunsaker, in forecasting the performance of a 100,000-lb airplane, flying nonstop from the United States to Europe,

gave the following performance data: Horsepower required, 4200; cruising speed, 130 mph; passenger accommodations, 12.

Again, allowing for a 20-mile head wind, Dr. Hunsaker's airplane would negotiate the transatlantic flight in about 33 hr or only 3 hr less than that required for the airship. However, the airship, due to its great fuel reserve and its ability to diverge from the great-circle route in seeking favorable winds, on many occasions should be able to overcome this 3-hr handicap. Furthermore, the airship should be able to maintain its schedule with greater regularity, since fog-bound conditions, either at the port of departure or at the destination, would not impose the danger in operation that is experienced by the airplane under similar conditions.

The writer desires to emphasize that the foregoing should in no way be interpreted as a criticism of the action of the last Congress which authorized the construction of a naval training airship duplicating the U.S.S. *Los Angeles* in type and in size. By all means this airship should be constructed as rapidly as possible in order that the talented and courageous group of naval officers and men, who in spite of great discouragement have remained loyal to the cause, may have an appropriate vehicle with which to carry on their important work. But it is contended that simultaneously the construction of a metal-clad, complying substantially with the general specifications herein proposed, should also be undertaken without further delay.

Mail

It is a pleasure to acknowledge publicly from time to time some of the communications that come to the editor. Frank A. Longo, boiler and welding supervisor of the Los Angeles General Shops, Southern Pacific Company, recently sent in a copy of *Proceedings*, the Journal of the Pacific Railway Club, for April, 1938, which contains a paper by him on "Boiler Drop Plugs." The paper recites the experiences of the Pacific Lines of the Southern Pacific Company with drop plugs and contains a summary of boiler explosions resulting from crown-sheet failures as reported by the chief inspector, Bureau of Locomotive Inspection, Interstate Commerce Commission, for the years ended June 30, 1932 to 1937, inclusive. In these six years, the yearly average number of locomotives for which reports were filed was 53,166, the average number of boiler explosions 7.5, and the average number of persons killed and injured 9.33 and 18.67, respectively. Of the average total fatalities from all causes on steam locomotives, those resulting from crown-sheet failure accounted for 59.6 per cent. In this same six-year period, Mr. Longo reports, with a yearly average of 1392 locomotives in service on Pacific lines, an average of 15 cases of low water have occurred per year, none of which resulted in serious damage to the boiler or caused injury to employees. It sounds like a fine record for the railroad. When someone asked Mr. Longo how he put water back in the boiler after the plugs had blown on the road he replied that he would rather bring in the locomotive "dead" than "blown up."

Another correspondent, J. E. Padgett, vice-president of engineering of the Spicer Mfg. Corp., and vice-president, S.A.E., sent in a little "primer" entitled, "Abundance for the Forgotten Man." It "seeks to give some fundamental truths about the major problems of today." Mr. Padgett says he feels that "our only salvation is the education of workers and those who want to work in what is truly of greatest benefit to them. I believe that engineers are best suited to develop these facts and give them to the world because their philosophy tends to have much more emotional balance. In twelve brief chapters, Mr. Padgett develops his ideas on goods or money, fruitful "busy-ness," fruitless taking; price—the distributor, price—the compass; the economic cycle; monopoly, labor and management; wages and hours; false prophets, government, and contentment; and ends with a list of seven ways in which "we can help create the foundation for abundance."

Ricardo Describes Detonation

INTERNATIONAL ENGINEERING CONGRESS, GLASGOW

NOBODY went to sleep during the reading of a paper "The Progress of the Internal-Combustion Engine During the Last Twenty Years," by H. R. Ricardo, at the International Engineering Congress, Glasgow, June 21, 1938. One reason was because Ricardo has won a name for himself by his researches in internal-combustion engineering; another was because many portions of his paper were vividly and amusingly expressed. Instead of shocking the serious-minded engineers from all parts of the world who assembled to hear the paper, it greatly pleased them and became the talk of the Congress. An excerpt, in which the process of detonation is described and which is a sample of Ricardo's unusual style, follows:

According to the simple rules, a mixture of air and petrol vapor, oxygen and nitrogen, hydrogen and carbon, is compressed in the cylinder; at the appointed time, a light is set to this highly inflammable mixture; there follows an instant of violent scramble and confusion; when the clamor and the fighting are lulled, it is found that the hydrogen has mated with some of the oxygen to form steam, the carbon has embraced the rest to form carbon dioxide, while the nitrogen remains unloved, disdainful, and alone.

With this simple and entirely orthodox evolution, we once were perfectly content, but inquisitive minds began to inquire what is really happening during the scrimmage itself, and more especially at, and even just before, the start of the scrimmage, and to suspect that, just possibly, every oxygen atom did not at once find its right partner, and, darkest suspicion of all, that the nitrogen's behavior was not quite so platonic as she would have us believe. Alas, the more deeply we probe, the more scandals we unearth. We find that the fickle oxygen has formed all sorts of unholy alliances before finally settling down to a steady partnership, while even the aloof, and apparently chaste, nitrogen has had at least one affair under cover of the general confusion, and a very disgraceful one at that.

In that one-thousandth part of a second or less, all kinds of unstable alliances have been formed and dissolved again, but some of them have endured long enough to exert a powerful and malign influence, while, in some cases, their very instability has itself been a source of danger.

Today it is realized that it is not the final partnerships, but the fleeting, excitable, and temporary liaisons that are the cause of all our worry, and the chief inciters of detonation; they, in fact, are the hotheads who start the roughhouse.

Many of these have already been identified, some few have been scotched, but many more are probably still undetected. For want of a better name, these illicit alliances are called products of partial combustion, because for the most part, they exist and have their being only during the actual process of combustion and disappear when combustion is complete, but not quite all; some, though probably only a few, are formed actually a little before the passage of the spark during the heat and confusion of compression. Thus, they are transient only, and cease to exist when combustion is complete and the oxygen atoms have found their permanent partners, but, when the wave of flame breaks on the cold shores of the cylinder walls, the process of combustion is suddenly arrested and the merrymaking halted abruptly. Here, then, on the extreme outer fringes, some of these illicit couples, these products of partial combustion, may be caught embracing, for the sudden chill of contact with the cold walls has frozen them rigid before they have had a chance to disengage themselves. When we search the wide ocean nothing do we find; it is by examining

the foam left behind on the shore that their existence can be detected.

It is certain of these transient products of partial combustion, probably the unstable peroxides, that are the active instruments in the cause of detonation, and today we do all in our power to be rid of them; an attempt is made to discourage their formation by introducing the hydrocarbon in the form of the more stable ring molecules, rather than the loose chains of the paraffin series, or again, an oxygen atom may be insinuated in advance into the molecule to act as a chaperone, as when using alcohol or acetone. In such matters, the rôle of the chemist and the designer is that of a social reformer in an uproarious and improper nightclub. The chemist can issue the invitations, and so, to some extent at least, can choose the company. The designer can insure that there are no secluded corners in his design of the room. In the last extreme, we descend to the rôle of the ratcatcher, and seek to poison these undesirables with dopes, such as lead tetraethide, better known perhaps as "ethyl fluid." By such means, success has been attained in reducing enormously the tendency of fuels to detonate, and thus in removing the greatest barrier to power output.

While certain of the transient products are the active instruments in detonation, some of those cast out on the fringes of the flame are the active cause of cylinder wear, for they burrow into and try to hide their shame in the walls of the cylinder barrel, like white ants in a packing case, and the colder the barrel, the more actively and the deeper do they burrow. In this direction nitrogen's liaison is now believed to be the worst offender of all, and the most eager to hide its shame.

Rolling Mill With Floating Rolls

IRON AND STEEL ENGINEER

A NEW type of steel-rolling mill has been developed during the past year by F. R. Krause, who describes its theory and operation in a paper appearing in ***Iron and Steel Engineer*** for August, 1938. It is claimed that the usefulness of the new method has been proved by operations on an experimental mill in which strip steel was cold-rolled from 4 to 12 in. widths from bars $^1/_8$ to $^3/_8$ in. in thickness by 20 ft long. Available power and the design of the mill limit the reductions when widths from 8 to 12 in. are rolled. However, $^3/_{16} \times$ 8-in. widths have been rolled to 0.018 in. and $^3/_{16} \times$ 12-in. widths to 0.025 in.

The operation of the mill may best be described in the diagrammatic drawing of Fig. 1, in which *A* is a crank drive which moves the housing *B* back and forth in bed *C*. The floating rolls *D* are held in alignment by cage *E*. The rolls are supported under the rolling load by the inclined and parallel surfaces of the housing and are held against those surfaces when no material is in the rolls by springs pressing against bearings on the trunnioned ends of the rolls. The air cylinder *F* manipulates the roll cage during part of the idle stroke (when no metal is between the rolls) and returns the rolls to their starting position at the end of each cycle. The hydraulic clamp *G* holds the blank *H* in a fixed position while the rolls engage the blank in the rolling operation. During the return stroke of the mill, the clamping pressure is released and the blank is fed forward an increment of its length by the intermittently operated pinch rolls *J*.

The illustration shows that part of the cycle in which the blank was fed forward and the clamping pressure is on in the cylinder holding the blank tightly between the end of the plunger and the adjusting screw. Air pressure is also on in the air cylinder *F* and holds the rolls in the starting position. As the crank *A* rotates counterclockwise, the mill housing *B* advances and forces the rolls to descend toward the blank (which they clear near the end of the idle crank stroke). As the rolls come into contact with the blank, the increment of length which was fed forward is being rolled out to the finish gage in this work stroke of the mill. On the return stroke of the crank, the mill housing and rolls are returned to the starting position while the clamp is released, the blank fed in, and clamping pressure applied again, thereby completing the operating cycle.

The floating rolls act as a die whose contact surface with the blank continually changes and rolls over the metal as it elongates, displacing it by pressing as in a press, and drawing as in a drawbench with an antifrictional die. It is due to this combined drawing and pressing action with the floating rolls of this process (which causes the metal to flow in a pass with diverging contact surfaces) that spreading of the metal is largely prevented. By floating rolls, it is meant that the rolls are not restricted by mechanical means in their movement along the blank and, therefore, can follow the elongation of the blank as the metal is displaced. It is claimed that a considerable power saving over a conventional rolling mill is possible with the new-type mill.

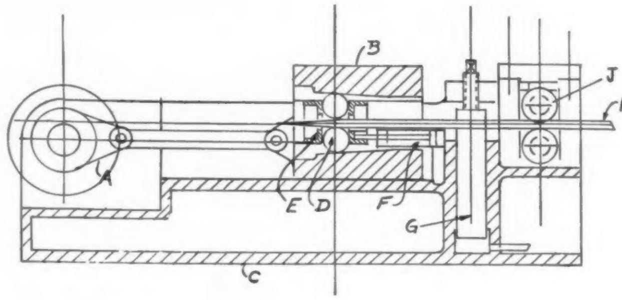


FIG. 1 DIAGRAM OF STRIP ROLLING MILL WITH FLOATING ROLLS

Aluminum Covering for Steel

STAHL UND EISEN

ALUMINUM as a surface covering for steel to protect it from corrosion is not new. There are four processes in use today by which an aluminum coating can be applied to steel, namely, by spraying it with aluminum, by plating it with aluminum by rolling, by hot-dip plating, and by calorizing. These various processes are discussed by Hubert Hoff in a paper appearing in the May 26, 1938, issue of ***Stahl und Eisen***, with particular reference to the rolling-on and hot-dipping processes as practiced in Germany.

In the rolling-on process, the aluminum is applied in the form of foil directly to the rolled steel strip, either hot, at temperatures of 300 to 400 C, or cold, at room temperature. Hot rolling has the advantage that the aluminum adheres to the steel by the use of a comparatively low pressure while, on the other hand, cold rolling does away with the expense of having a furnace for the preheating of the steel.

However, if the plated material is required for deep-drawing purposes, it must be soft-annealed after rolling. This produces a difficulty, since aluminum combines with steel at temperatures of 500 to 600 C to form $FeAl_3$. Experiments by the author and others show that basic Bessemer steel can be used since its

reaction with aluminum does not take place until after 600 C. But since basic Bessemer steel does not possess good deep-drawing properties, it was found necessary to develop a similar nonreactive open-hearth steel by increasing its oxygen and nitrogen contents. Addition of silicon has been found to be another way of overcoming the difficulty.

The discussion of the methods of hot-dip plating aluminum on to steel include the Dellgren, Fink, and Rodriguez processes. The disadvantage of the hot-dip plating process, as compared with the rolling-on process of plating, consists chiefly in the fact that the formation of the deleterious $FeAl_3$ intermediate layer cannot be avoided owing to the instantaneous reaction of the molten aluminum with the steel. On the other hand, the process has the advantage that it is not necessary to use aluminum foil, and it is also possible to plate shaped parts.

In the calorizing process, the parts are brought into contact with a mixture of aluminum powder, ammonium chloride, and alumina, in slowly-rotating drums at temperatures of 850 to 900 C in an atmosphere of hydrogen or the parts may be embedded in the mixture in iron boxes. Another process does not require the use of hydrogen but, instead of aluminum powder, uses a powdered aluminum-iron alloy (40 to 50 per cent Fe). The cleaned metal parts are packed into the mixture in tightly closed iron boxes and heated to 900 to 1000 C. This causes a gradual diffusion of the aluminum into the surface of the parts, resulting in the formation of a layer of $FeAl_3$ covered by a very thin layer of pure metallic aluminum. Further heating causes the aluminum to penetrate into the steel, causing the surface to lose its silvery-white color and to take on a dull gray finish.

Since aluminum does not oxidize as fast as zinc, it protects the underlying steel much longer from corrosion. Aluminum-coated steel has found widespread use in the packaging industry and aluminum-plated steel tubes have replaced lead as a covering for cables in Germany.

End-Gage Comparator

ENGINEERING

AN END-GAGE comparator, capable of measuring differences between such gages to an accuracy of a millionth of an inch and adjustable for use with gages up to a length of 5 in., has been developed by the National Physical Laboratory (Great Britain) and is described by A. Turner and F. H. Rolt in the August 12, 1938, issue of *Engineering*.

The principal aim of the design, according to the authors, was to produce a comparator with a magnification factor of 30,000 to 1 and of such a form that several block gages up to 5 in. in length could, in turn, be readily stood or slid into position under the measuring head. The amplification is obtained by the combination of mechanical and optical levers. The measuring head of the instrument, which is completely described by the authors with the aid of appropriate drawings, is about $1^1/_8$ in. in diameter and 6 in. long.

Fig. 2 shows the arrangement of the body and the optical system. The gages to be compared are mounted on the horizontal table *a* and are passed in turn under the measuring contact of the indicator *b*. The latter contains a lever system terminating at the top in a tilting mirror, the deflections of which are observed by means of the optical system. This consists of an overhead lamp *c*, across the condenser of which is stretched a short length of fine copper wire. The beam of light from this lamp is concentrated on the tilting mirror of the indicator which reflects it upward on to a fixed plane mirror *d* placed near the lamp. Here it is again reflected downward and finally falls on a scale *e* situated in front of the body of the machine. The scale is graduated to read directly in hundred thousandths of an inch. The scale has a range of 0.0004 in., so that differences up to that amount can be dealt with. The over-all magnification of the machine is 30,000, so that a difference between the gages of 0.00001 in. gives rise to a linear displacement of the image on the scale of about 0.3 in.

In order to accommodate the instrument to gages of different lengths, the table is supported on a stout plunger which can be raised and lowered inside the main body of the machine by a

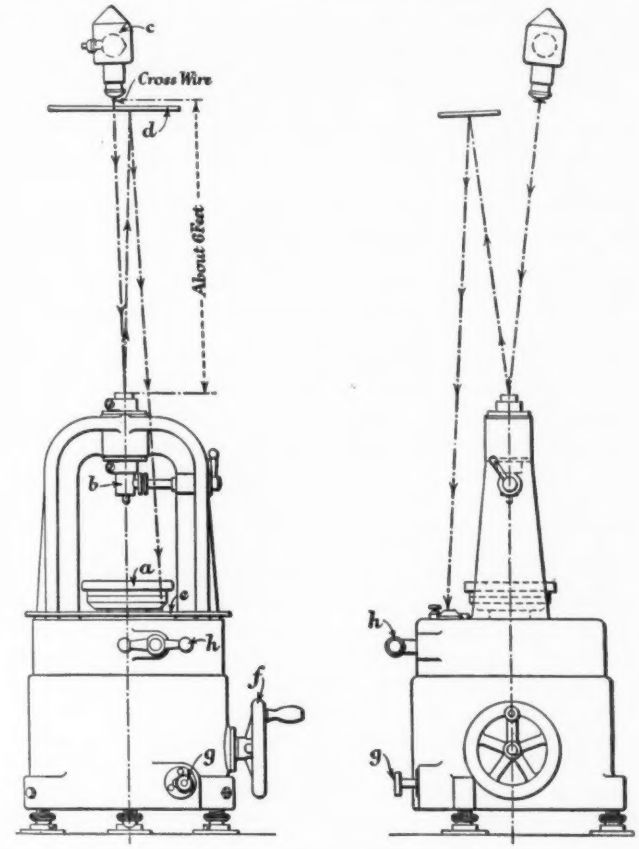


FIG. 2 DIAGRAMMATIC OUTLINE OF END-GAGE COMPARATOR OF HIGH SENSITIVITY AND ITS OPTICAL SYSTEM

screw and nut operated from handwheel *f*. The knurled head *g* provides a sensitive final adjustment to this movement, and the plunger is securely clamped by the handle *h*.

The machine was constructed in the Metrology Department workshop and was erected in the thermostatically controlled room of the National Physical Laboratory reserved for the measurement of standard gages.

Explosive Tools

ARMY ORDNANCE

EXPLOSIVES in the solid form have been used for centuries in guns, for blasting, and more recently as a source of power for small portable tools. With a tool weighing as little as five pounds, an operator instantaneously can establish a pressure of up to 50,000 lb per sq in. to drive a pointed pin through superimposed plates, to compress a sleeve around the

ends of a cable, pipe, or other similar element, and for many related working operations. An article on the development and uses of various explosively actuated tools has been written by A. H. Oldham and appears in the May-June, 1938, issue of *Army Ordnance* from which the following excerpts are taken.

In the construction of metal aircraft in Germany, explosive rivets have solved the problem of getting at joints which can be reached from one side only. As shown in Fig. 3, a cup is drilled into the end of an ordinary alloy or steel rivet, and the cup filled with explosive. After the rivet is pushed into the hole, a hot holding-up tool having a silver or an aluminum head (copper is unsuitable) is held against the head of the rivet. In about five seconds the rivet reaches a temperature of 266 F and the explosive goes off with a force which bulges over the sides of the cup enough to form an adequately strong head. No corrosion or harm is caused to the rivet or the adjacent and opposing members of the structure. The rivets are about 85 per cent as strong as rivets driven by the regular method.

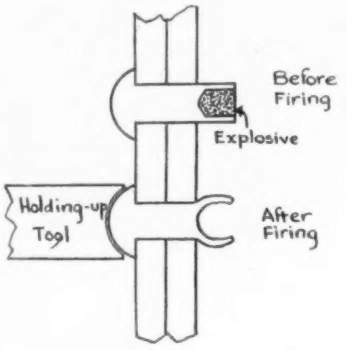


FIG. 3 EXPLOSIVE RIVETING

In a portable cable-cutting apparatus, the detonation of a readily replaceable blank cartridge effects relative movement between a pair of shear blades to achieve the desired cutting operation. A noteworthy and important characteristic of explosive tools which is inherent in most of them described in this article is that the piston or other parts driven by the expanding gases of the detonated powder charge does not leave the barrel. This also confines the expanding gases so that noise in operation is largely eliminated, as is recoil.

A particularly interesting use of explosives is in the construction of apparatus for rapidly breaking an electric circuit upon overload of the circuit or in case of fire. A wire of small diameter extends through an explosive charge positioned behind a piston carrying the main flow of electric current. An overload on the circuit overheats the wire and causes the detonation of the explosive charge which operates the piston so that it breaks the flow of current through the circuit. Improvements have been made so that a magazine is provided for receiving a plurality of blank cartridges which can be detonated in turn by remote control to release or reset the circuit breaker. In another apparatus, the contacts carrying the electric current are driven apart instantaneously by the same cartridge which trips the circuit breaker.

Many engineers, especially those in aeronautics, are familiar with the explosive starting of airplane engines by means of a pistol-like mechanism secured to the end of a storage cylinder near the pilot's seat. Conduits extending from the cylinder to the airplane engine and a suitable valve distributor arrangement apply the pressure built up in the cylinder by the detonation of a blank cartridge to the individual cylinders of the airplane engine in turn so that a starting action is produced.

Although hydraulically and screw-actuated dies were used for many years to connect cables and pipes together by compressing a sleeve around the ends thereof, until quite recently no one discovered that the heavy, slow, hydraulic, and screw mechanisms could be replaced by light and almost instantaneous explosive means. These latter methods have made it possible to develop pressures up to 50,000 lb per sq in. or more by portable tools which can be used to join cables or other strand elements together almost instantaneously. Such tools also can be used to join cables to eyes or other similar members. Tests on joints made by this apparatus have found them to be so strong that the cables break before the joints let go.

A particularly interesting use of explosives is found in the piercing of an oil-well casing by suitable guns so that different oil strata in the cased well can be tapped. The apparatus consists of a steel body and pointed pins mounted on slides for horizontal movement. Pistons having an explosive powder charge are received between the pins so that upon detonation of the powder charge by an electric cable extending to the top of the well the pointed pins are driven outwardly to pierce the casing walls.

There is a gun for shooting clinker rings out of a cement or lime kiln without shutting down the furnace. Other explosive devices make it possible to separate taper-fitted machine parts and to make rail bonds.

Variable-Pitch Propeller

ALLGEMEINE ELEKTRICITATS-GESELLSCHAFT

VARIABLE-PITCH propellers operated by electrical and hydraulic methods have been described in this section several times. Patents covering a pitch-changing mechanism operated by the expansion of heated air and the contraction of cooled air were recently granted to Nicholaas E. Groeneveld Meijer, the American representative of Allgemeine Elektricitats-Gesellschaft.

The mechanism is enclosed in the hub of the propeller and the change in pitch is effected by heat, generated by an electric coil. The heat causes metallic cylinders, telescoped within one another, to expand. These sleeves are connected to the pitch-changing mechanism. The coil heats the cylinders when the current is applied by the pilot from a switch in the cockpit. The amount of heat used to expand the sleeves is controllable so that any desired pitch may be obtained. Cold air is used to cool the cylinders to contract them.

Another way of obtaining the force to change the pitch is derived from a metal bellows filled with a liquid which has a high coefficient of expansion. A hermetically sealed heating element is inserted in the bellows and by heating the element, the liquid expands and expands the bellows. This in turn exerts the force necessary to change the pitch of the blades.

In still another method Meijer features the use of exhaust gases as a source of heat to operate the pitch-changing mechanism, instead of electric-heater coils. Exhaust gases are conducted from the engine to the expansion elements of the mechanism. A three-way valve admits gas, cold air, or any desired mixture of the two, to the expansion unit of the propeller. The setting of the valve, which can also be controlled automatically, then determines the pitch of the blades.

Relief of Stress in Castings

ENGINEERING

EXPERIMENTS conducted for the purpose of finding out what annealing conditions are necessary for the removal of internal stresses in castings were discussed in a paper by L. E. Benson and H. Allison before the Institution of British Foundrymen, June 17, 1938, an abstract of which appears in *Engineering* for August 19, 1938.

Tests were made on cast iron, carbon steel, Admiralty gun metal, and a high-tensile bronze. With each material, test pieces were carefully machined and ground to size, and pairs of test pieces were fitted together with a stirrup in the middle, the ends being separated by small distance pieces as shown in Fig. 4. The size of the stirrup and the thickness of the distance pieces were chosen to give the required maximum bending stress at the middle of the span. Each assembly was then annealed in an automatically controlled furnace, and, after cooling, the residual stress was calculated from the amount of straightening which occurred when the test pieces were re-

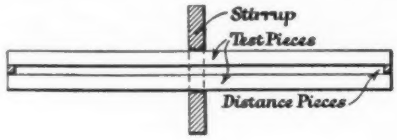


FIG. 4

leased from the stirrup. The tests on the several metals used and the results are described and the following conclusions are drawn:

Under the conditions of the experiments, which were chosen to represent practical conditions as far as possible, it has been shown that substantial stress relief can be obtained by annealing at approximately the following minimum temperatures:

Admiralty gun metal	400 C
High-tensile bronze	500 C
Cast iron	550 C
Carbon steel	600 C

It has been shown that annealing gray cast iron appreciably in excess of 550 C will produce measurable growth. It may also be pointed out that annealing certain steel castings, notably molybdenum-steel castings, much in excess of 650 C, but below the critical range, will bring about spheroidization of the carbide constituent, possibly with very detrimental results as regards the creep strength of the material, i.e., the property for which these steels are particularly valuable.

The effect of the length of the annealing period is of secondary importance, at any rate within ordinary commercial foundry practice. The temperature–stress-relief curves are steep, however, and for this reason it is essential that sufficient soaking should be allowed for the castings to attain the annealing temperature throughout. Under ordinary shop conditions there is generally a very big lag in temperature between the job and the control thermocouples unless a practice is made of deliberately placing thermocouples in suitable holes in the castings themselves, or, if not convenient, in holes drilled in blocks of metal of representative dimensions compared with the charge. The experiments made show that it is quite erroneous to suppose that in iron or steel castings any large measure of stress relief can be obtained by aging at atmospheric temperature or by annealing at temperatures such as 150 or 350 C. The impression conveyed by some specifications in this respect is unfortunate.

The annealing treatments considered by the authors will produce effective stress relief at the annealing temperature, but the parts when cold will not necessarily be still stress-free. Internal stresses are generally the result of uneven temperature distribution during cooling down, particularly while cooling through the temperature at which the material changes in character from plastic to elastic—say 600 to 350 C for steel and cast iron. Cooling from the stress-relieving temperature may set up a system of internal stresses therefore, as well as cooling after casting or after a high-temperature annealing treatment. To avoid this possibility, furnace-cooling is recommended, and the authors' experience indicates that cooling in a closed furnace to 100 C is satisfactory, even for such important steel castings as turbine cylinders and large steam chests. Small parts of even section may be air-cooled without serious detriment, but it is difficult to draw the line in practice, since castings are not generally of even section and large temperature differences would be likely on cooling in air.

Steel castings are almost always annealed at a temperature in the region of 900 C and are frequently given a second treatment at 600 to 650 C after rough-machining. In view of the fact that internal stresses become dissipated at about 600 C it is clear that the internal stresses to which the engineer objects are not the result of cooling down after casting or forging as sometimes supposed, but have been developed by uneven cooling after annealing. It may even happen, through lack of appreciation of how internal stresses are developed and relieved, that the second annealing treatment is more detrimental than beneficial. For example, castings annealed at 900 C and slowly cooled may be internally stress-free and actually in better condition than after a second treatment followed by comparatively rapid cooling. It is the last treatment that counts, and in the authors' opinion one properly controlled heat-treatment is thoroughly satisfactory unless exceptionally heavy machining is done subsequently. In any case, one properly controlled annealing is preferable to repeated annealing treatments if due regard is not paid to the final cooling conditions.

As regards annealing stresses in steel parts, it is only fair to say that the authors' experience is that the foundry is less culpable than the forge. Whether iron foundries are in such a strong position is a debatable point, since many iron castings are not annealed at all. The need for annealing will depend, of course, on the degree of internal stress that can be tolerated and the uniformity of temperature that can be maintained as the castings cool, particularly through the range 550 to 350 C.

Ford's Rear-Engined Auto

U. S. PATENT OFFICE

PRESAGING the manufacture on a mass-production basis of rear-engined passenger autos, the U. S. Patent Office early in July granted to Henry Ford, member A.S.M.E., a patent for a rear-axle-engined auto. Three and a half pages, several diagrams, and seven claims are used to describe the arrangement of a V-type 8-cylinder engine, transmission, differential, flywheel, driving sleeve, and other parts, all over the rear axle.

As shown in Fig. 5, which is one of the drawings contained in the patent description, the engine is mounted in a transverse position on one side of the rear axle. In the center are the transmission and differential housing fixedly secured to the inner end of the engine, while the engine flywheel, clutch, and other heavy parts are on the other side helping to balance the engine's weight.

In his application, Mr. Ford claims that in the past considerable difficulty has been experienced with all driving units of like nature because of the difficulties in maintaining exact alignment between the various units comprising the assembly. According to the inventor, it is extremely costly to machine the various parts so that the axis of the engine crankshaft is exactly aligned with the axis of the transmission and driving pinion. In all other assemblies of like nature, if such alignment is not maintained, excessive wear in bearings results causing a shift of alignment and noisy operation.

One of the claims of the new patent is that the engine as-

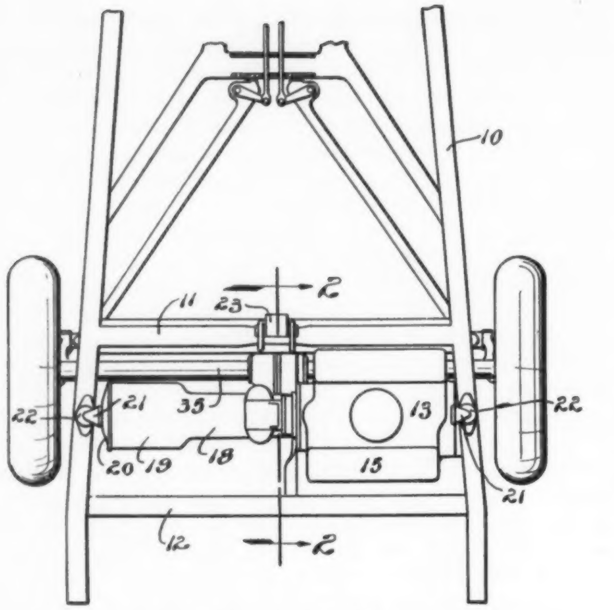


FIG. 5 PATENT DRAWING OF FORD'S REAR-ENGINED AUTO

sembly designed by Mr. Ford permits an appreciable amount of out-of-line operation without the attendant difficulties found in other types of assemblies.

Plastics in Aircraft Construction

JOURNAL OF THE AERONAUTICAL SCIENCES

PLASTICS are slowly finding a place as structural materials in the construction of aircraft, especially in England and Germany. A summary of the experiments and applications in these and other countries has been prepared by Gordon M. Kline, National Bureau of Standards, and appears in the *Journal of the Aeronautical Sciences* for August, 1938. An abstract of the paper follows:

Most of the experimental work on the use of plastics in aircraft construction has been with the phenol-formaldehyde resin type, known in America by such trade names as Bakelite and Durez. This material is the least expensive of the synthetic resins and is thermosetting, i.e., it cures during the molding process to an infusible, insoluble mass. The thermoplastic materials, such as the cellulose derivatives, and vinyl and acrylic resins, which can be alternately fused and hardened by raising and lowering the temperature, are probably too liable to cold flow to be useful as structural materials.

Phenolic plastics are usually made up of two distinct ingredients, the resinous binder and a reinforcing agent. The raw materials for the resin are generally formaldehyde and phenol (also known as carbolic acid) or technical cresol. Furfural, an aldehyde which can be obtained from various natural sources, e.g., oat hulls, cornstalks, and the like, by distillation with acid, is sometimes substituted for the formaldehyde. The selection of a reinforcing material and its incorporation into the composition in such a manner as to utilize to a maximum its capabilities, has been the subject of considerable investigation.

In the usual molding composition the resins are mixed with ground or shredded fibrous fillers, such as wood flour, cotton flock, or comminuted canvas. These fibrous materials not only reduce the cost of the plastic, but also improve its mechanical properties, particularly its tensile and impact strength. Plastics of greater mechanical strength are produced by employing paper or cloth as the reinforcing medium. These laminated materials are prepared by impregnating the sheets with a solution of the resin while it is still in a soluble state, drying them, and then bonding many layers together by the application of heat and pressure. This treatment converts the resin to the infusible, insoluble state and yields a hard, dense product which will not delaminate and possesses excellent mechanical strength and weathering resistance.

Recently, a German observed that products superior to the paper- or cloth-laminated type in certain physical proper-

TABLE 1 PHYSICAL PROPERTIES OF REINFORCED PLASTICS, WOOD, AND METALS, COMPILED FROM VARIOUS SOURCES BY G. M. KLINE (Reproduced from the *Journal of the Aeronautical Sciences*)

Material	Specific Gravity	Tensile Strength Lb./Sq. In.	Ratio of Tensile Strength to Specific Gravity Lb./Sq. In.	Compressive Strength Lb./Sq. In.	Ratio of Compressive Strength to Specific Gravity Lb./Sq. In.	Modulus of Elasticity in Tension (E_t) Lb./Sq. In.	Ratio of E_t to Specific Gravity Lb./Sq. In.	Modulus of Elasticity in Compression (E_c) Lb./Sq. In.	Ratio of E_c to Specific Gravity Lb./Sq. In.
Stainless steel (18-8)	7.85	185,000	23,600	150,000[a]	19,100	30,000,000	3,800,000	30,000,000	3,800,000
Chrome molybdenum steel (heat-treated)	7.85	180,000	22,900	150,000[a]	19,100	29,000,000	3,700,000	29,000,000	3,700,000
Aluminum alloy (24-ST)	2.80	62,000	22,100	40,000[a]	14,300	10,400,000	3,700,000	10,400,000	3,700,000
Magnesium alloy (Am58S)	1.81	46,000	25,400	35,000[b]	19,300	6,500,000	3,600,000	6,500,000	3,600,000
Aircraft spruce (Douglas fir)	0.43	10,000	23,300	5,000	11,600	1,300,000	3,000,000	1,300,000	3,000,000
Birch plywood	0.80	13,100	16,400	5,700	7,100	1,400,000	1,800,000		
Birch-reinforced resin	1.27	27,700	21,800	22,800	18,000	3,400,000	2,700,000	2,300,000	1,800,000
Paper-reinforced resin	1.37	19,000	14,000	30,000	22,000	1,200,000	900,000	600,000	400,000
Fabric-reinforced resin	1.37	10,000	7,200	40,000	29,000	1,000,000	700,000	600,000	400,000
Cord-reinforced resin	1.37	25,000	18,700	27,000	20,100	5,900,000	4,300,000	600,000	400,000

[a] Yield point in compression.

[b] Yield point in tension. Yield point in compression is substantially equal to yield point in tension for wrought alloys.

ties, especially modulus of elasticity in both tension and compression, could be prepared by impregnating extremely thin wood veneers of 0.004 to 0.012 in. thickness with resin and forming them into a multilayered cured sheet in the usual manner. Cord or long-fiber reinforcing agents have been used to obtain maximum tensile strength, incorporating only the minimum amount of resin required to bind these fibers together. Similar results with fibers of agave, sisal, and aloe have been reported.

Some of the physical properties of these various types of plastics which are pertinent to their use as structural materials for aircraft are summarized in Table 1 from various publications by the author. Similar data reported in the literature for the materials which have been employed for fabricating aircraft, namely, high-tensile steels, aluminum and magnesium alloys, aircraft spruce, and birch plywood, are quoted for purposes of comparison.

Four methods of joining various sections made of reinforced phenolic material have been suggested, namely, cementing, riveting, bolting, and keying by interlocking joints. The synthetic-resin cements have better aging properties and moisture resistance than the protein glues heretofore employed by the aircraft industry. Joints can be made between laminated phenolic-resin plastics that will have a strength of 2000 lb per sq in. or more in shear. Greater strength may be achieved if the surface of the plastic is etched or sandblasted so as to expose the fibrous reinforcing material to the action of the cement.

With respect to the feasibility of riveting and bolting structures made up of reinforced phenolic plastic, bearing strengths of 26,300 to 37,000 lb per sq in. have been reported for bolts ranging in diameter from $^3/_8$ to $^3/_{16}$ in., respectively. The method of keying by the use of interlocking joints has been used in metal aircraft construction and should also be applicable to structures made from reinforced resinous products.

Controllable-pitch propeller blades have been made from reinforced plastics in this country and are currently being manufactured in Germany and England. An airplane, in which the wings and fuselage were each molded in one piece of extremely thin laminated films of wood and cellulose acetate, was designed, built, and successfully flown. But this type of material is not believed to be suitable for general use in aircraft construction because plastics made with cellulose acetate are subject to cold flow under low loads and to considerable variation in moisture content at different humidities, resulting in excessive dimensional changes and warping.

However, according to Mr. Kline, until more information is available on the problem of combining resin and reinforcing agent in such manner as to obtain requisite strength and stiffness and until such products have been thoroughly tested to determine their behavior under repeated stresses, it is too early to expect to make any considerable progress on the design and fabricating problems involving plastics in aircraft construction.

The construction of the wings of a British airplane from plastic materials was described in this section in the January, 1938, issue of Mechanical Engineering.

Pickle-Liquor Plastic

BUSINESS WEEK

According to an article in *Business Week* for Aug. 20, 1938, a process has been developed by H. S. Colton, Cleveland chemical engineer, for converting waste pickle liquor from steel mills into a plastic called "Ferron," thus helping to solve the problem of steel-mill stream pollution.

This waste pickle liquor is an aftermath of pickling steel in sulphuric and other acids to remove scale and oxides. Fresh acid can be added to the pickle bath as fast as it is consumed until a point is reached when the solution is so saturated with iron salts that it must be dumped into any handy stream and a fresh bath prepared. Though any free sulphuric acid in the liquor may be neutralized with lime before dumping, the ferrous sulphate in the liquor gradually hydrolizes in the stream, forming large volumes of weak sulphuric acid which attacks fish life, steel barges and piers, and the boilers and condensers of factories located farther downstream.

The process for making Ferron is relatively simple and inexpensive and requires no great capital outlay for equipment. The resultant tan-colored solid material consists largely of co-precipitated iron hydroxide and calcium sulphate. During manufacture, it goes through a plastic state and may be molded into almost any desired form which later sets into a hard mass by a combined process of drying and oxidation.

Ferron resembles wood in that it may be sawed and nailed, but it is proof against fire, termites, and warping. It resembles plaster, but it withstands higher temperatures without losing its strength. It resembles fired clay and brick, but it weighs only one third as much. Its insulating value is high because it holds a high proportion of entrapped air.

Present plans for the commercialization of Ferron, soon possible in a new plant being built in Sharon, Pa., call for its conversion into wallboard, pipe covering, building block and brick, insulating clay for boilers, and various applications in the chemical industry. One unexpected consumer use turned up when it was discovered that silver kept in boxes made of Ferron apparently does not tarnish.

Housing Research

NATIONAL BUREAU OF STANDARDS

In June the National Bureau of Standards issued the first of a series of reports on building materials and structures entitled, "Research on Building Materials and Structures for Use in Low-Cost Housing," by Hugh L. Dryden, member, A.S.M.E. The report, which is procurable from the Superintendent of Documents, Washington, D. C., for 10 cents, describes the objectives, procedure, scope, and detailed programs of research carried out at the Bureau under a committee of its division chiefs with the advice of representatives of the housing agencies of the government.

The general objective is stated as follows: To furnish to government agencies, the building industry, and the public technical information from every available source on the engineering properties of building materials as incorporated in the structural elements and equipment of a house, with particular reference to low-cost housing, and including new materials, equipment, and methods of construction as well as those already in use.

The Bureau will not consider sociological, economic, hygienic, or aesthetic questions involved or the design of houses. Its investigations will consider a house as composed of elements, such as walls, partitions, floors, roof, plumbing, and heating, and the construction of an element is defined as the design, dimensions, materials, method or process of fabrication, and workmanship of the element.

The program will include elements suitable for detached houses, row houses, and low-cost apartment houses; it will in-

clude new as well as conventional constructions; and to restrict it to constructions and equipment suitable for a low-cost house, a maximum cost has been fixed for each element.

Cooperation with industry is to be fostered. The resources of the entire building industry are to be mobilized, and reliance is to be placed on industry to initiate new developments, while the Bureau performs the function of a disinterested fact-finding agency.

Projects approved at the beginning of the program included structural properties of walls, partitions, roofs, and floors; fire resistance of walls, partitions, roofs, and floors; thermal insulation, moisture condensation; weathering of roofing materials; floor coverings; heating and plumbing equipment; infiltration and ventilation; durability of fiber boards; corrosion of painted galvanized steel sheets; rain penetration of masonry; calking materials; simplified-practice recommendations; and commercial standards.

It is stated that "the National Bureau of Standards is a fact-finding organization; it does not 'approve' any particular material or method of construction." It is further stated that the Bureau does not have facilities to undertake the testing of any and all materials for the public; that its policy is not to compete with commercial testing laboratories; and that regulations provide that it shall not make tests of materials and appliances for the general public if they can be made elsewhere.

Homes for Engineers

THE ENGINEER

A NOTEWORTHY and laudable plan for the benefit of members and their dependents who are in need has been initiated by the Benevolent Fund of the Institution of Civil Engineers in England, according to an article in the July 8, 1938, issue of *The Engineer*. The freehold of an estate of a little over 5 acres, known as Mill Hill Close, has been acquired at Haywards Heath, Sussex, whereon it is proposed to erect 38 houses, at a total cost of about $175,000, inclusive of land and landscaping. In the first instance it is intended to erect at least 20 houses, and the purpose of an appeal signed by Bryan Donkin, president of the Institution, and dated July 4, is to obtain a capital sum of not less than $100,000 toward the cost of carrying out the plan.

Mr. Donkin stresses the urgent need for such housing accommodation. At present many of those assisted by the Benevolent Fund live in rooms or lodgings situated in poor and crowded districts at rents proportionately high for the accommodations furnished. The houses to be erected on the Mill Hill Close estate will provide homes more in keeping with the standards of living to which those who will occupy them have been accustomed, and will enable better supervision and care to be given in the case of the old and infirm and in the event of sickness.

According to Mr. Donkin, since this is the first plan of its kind promoted in connection with a professional engineering society, it is essential that it should in every way be worthy of the profession and that the residences provided should in no sense be suggestive of a charitable institution. With this end in view the Committee on Management has chosen the site after very careful consideration and has engaged the services of an architect who has had considerable experience in housing estate work in the locality.

It has been suggested that some members of the Institution, or a group of members and their friends jointly, might like to name a house, and provision will be made for them to do so on payment of a donation of $2500. Nearly $10,000 has been already subscribed by the members of the Home Appeals Committee. Although housing plans of a somewhat similar nature are not rare, the editors of *The Engineer* believe this is the first time that a great institution has undertaken one, and think it is also the first of its kind for the benefit of engineers. In its magnitude it is worthy of the Institution of Civil Engineers.

Men and Machines

THE IRON AGE

IS THE MACHINE responsible for the army of 12 million unemployed in the United States, supplemented by 20 million dependent women and children? This question is answered based on facts obtained through much study and research, in an article in the June 9 and June 16, 1938, issues of *The Iron Age* by John H. Van Deventer, editor, who has used the automotive industry, undoubtedly the most highly mechanized of all industries, to illustrate his points. High lights of the paper, which was presented on June 6, 1938, before the Economic Club of Detroit, follow:

The richest gold field in the world is that of South Africa. During its productive life time, it has so far produced a total value in gold of approximately seven billions of dollars. Let us see what the equivalent in employment opportunity and money wages has come from Detroit and her sister cities throughout this land because of the automobile industry.

When the automotive pioneers—Ford, Leland, Briscoe, Durant, and others—first discovered gold on the plains of Michigan, there was not a dollar's worth of employment or of wages available in the industry. It started from scratch. Since 1900 and including 1937 there had come from that modest little original discovery a golden flow of wages aggregating the stupendous sum of 84 billions of dollars; wages directly traceable to the automobile and which would not have existed except for it.

Think of it! Eighty-four billions of dollars in 38 years from the golden fields of Michigan alone and spreading its consuming power from coast to coast throughout this country. Five times as much value taken in wages from this apparently inexhaustible employment mine as the value of all the gold mined in the whole world in the same period. It now provides employment to one in every seven workers gainfully employed in the United States.

Ever since the beginning of the machine age, we have progressed toward higher and higher standards of living, toward higher wages, toward more employment opportunity by following the basic prosperity formula. The automobile industry stands foremost as an exponent of this formula which is a simple one. It is this: More power, better machinery, better output per man-hour, higher wages, and more customer value in price or in quality.

The automobile industry has its faults and its shortcomings and there is plenty of room in it for improvement, but it is an industry whose record no serious student of economics can afford to overlook. As the most intensively mechanized industry in the world, its performance has demonstrated conclusively the compatibility of men and machines when cooperating according to the terms of the prosperity formula. But it has done more than this.

Whether by chance, whether by the blind force of driving competition, or whether by superior executive caliber in its management is immaterial, but this industry apparently has hit upon a perpetuating principle which others will do well to study. It has learned that it pays to divide its efficiency gains

among its customers, its workers, and its investors. Here is an industry which, even during the troublesome times since 1929, has benefited its customers by 738 million dollars, its workers by 644 million dollars, and its investors by 400 million dollars. Of each dollar of the increased wealth this has given the largest share to its customers, the next largest to its workers, and has retained the smallest portion for dividends and surplus.

The ratios of this division may not be ideal but the principle involved is the basic stimulant of consumption. When that principle becomes adopted and properly applied by all industries in America, we shall see the end of the imaginary conflict between employers and employed. For then, having mutually solved the problem of division, we can unite with the machine for solving the problem of multiplication of production and consuming power that alone can lead to sound and progressing prosperity.

Plastic Printing Type

MODERN PLASTICS

GERMAN ENGINEERS, it is claimed, have made the first change in material for printing type since lead alloy was substituted for wooden type faces. The new material, according to an article in the June, 1938, issue of *Modern Plastics*, by Alexander Ball, is a thermoplastic capable of pressure casting in monotype or linotype machines. The new plastic type has been used commercially in Germany and is claimed to offer an advantage of greater elasticity and, made up in forms, about one tenth the weight of lead alloy.

Development of a plastic for type faces has been under way for several years, primarily by Dr. Bekk and Ernst Strunk. It has been done under the German four-year plan for production of *ersatz* or substitute products to make Germany as nearly self-sufficient in raw materials as possible. Progress of the plan in all materials is published monthly in an official magazine, *Der Vierjahresplan*. Readers of the February number of the magazine, one of the best typographically in Germany, were amazed to find in its pages an announcement that four pages were printed from *kunstofflettern* (type of acetate plastic). The fact that the magazine has a circulation of 80,000 was indication that plastic type has durability as well as elasticity and lightness. No difference was discernible in a comparison of the plastic printed pages with the rest of the book.

Photomicrographs of single letters of plastic compared with lead-alloy type after a run of 100,000 impressions have indicated practically as little wear as on ordinary metal type. The new type is not only being used as standard movable type, set by hand, but is also used in typesetting machines.

The plastic used is stored in a melting chamber attached to the type-founding machine. In typesetting machines, the keyboard, setting devices, and the lockup and later distribution of type are unchanged from traditional practice. Certain changes are made in the melting heat and at the prescribed temperature the plastic is pressed through nozzles into the matrices. The process corresponds to die casting or, in the case of plastics, to injection molding. After use in a form, the synthetic-resin letters may be washed with benzine or other cleaners and do not suffer from humidity or corrosion. The elasticity is claimed to be higher than that of type metal. The exact analysis of the plastic material is still kept secret. The substance was originally transparent, but as this proved impractical for printing, it was colored gray, the color turning brown after repeated remelting.

In addition to the fact that forms of plastic type weigh only one tenth the usual weight, it is further pointed out that with lighter forms, the presses may be constructed lighter without a decrease of the force necessary for clear impressions. At present, in the application to a typesetting machine, only four, up to in some cases ten, castings may be effected per minute. This might suffice for linotype machines, but for single-type castings, where speeds of 3000 to 4000 letters per hour are attainable with present type metals, this is slow. The remedy may consist in casting a large number of letters at one time. However, experimental work is still continuing.

A Useful Rubber Product

THE RUBBER AGE

PLIOFILM is the name given to a hydrochloride of rubber in the form of pliable transparent sheeting which has been developed by the rubber industry, according to an article in *The Rubber Age* for August, 1938.

While the new product is a derivative of rubber, it is decidedly different in many of its fundamental properties. Similar in appearance to cellophane, it embodies a great many of the essential elements of a serviceable and practical material. Its chief characteristic is resistance to free liquids, such as water, oil, weak acids, and alkaline solutions, and, because of its dense molecular structure, it is highly moisture-vapor proof. Also, in its regular form it is odorless and tasteless and is not affected by mold or insects.

Its use for packaging purposes has been somewhat delayed because of the large demand that arose from other applications, such as raincoats, raincapes (selling for 25 cents each), shower curtains, garment bags, and similar items. A plentiful supply is now, however, assured. Colorless, transparent sheeting is produced in five standard thicknesses ranging from 0.0001 to 0.0025 in. and several different qualities with varying amounts of plasticizers. In spite of its dense structure, pliofilm is unusually light and affords an exceptionally large surface area per pound; for example, with a thickness of 0.001 in., the area is 25,000 sq in. per lb of material. Besides the clear type, it can be produced in a wide variety of colors with transparent, opaque, or metallic effects.

Unlike most transparent sheetings, pliofilm is moisture proof in itself and does not depend for this essential characteristic upon a minutely thin protective coating. Consequently, normal handling and converting operations such as folding, creasing, laminating, printing, and heat sealing do not impair its moisture-proof quality. As it has no inherent moisture content, it does not dry out and shrink, which, with its ability to resist moisture and absorption, makes for excellent dimensional stability and freedom from wrinkling and drawing. It does not lose moisture and become brittle when subjected to prolonged exposure in an unusually dry atmosphere; nor does it have any tendency to absorb moisture when exposed to unusually damp atmosphere.

Because of its high tear resistance and ability to stretch, the sheeting resists puncturing, and its pliability permits it to conform readily to irregular surfaces over which it may be wrapped. The strength of pliofilm is not materially affected by low temperatures. When it is heated, it becomes ductile and plastic, and, while in this condition, it can be stretched or formed to conform with any irregular contour. Also, while in this plastic state, it tends to adhere to itself, a unique characteristic which may lead to many new and unusual applications.

Pliofilm may be welded or sealed in three ways—by heat alone, by a combination of heat and solvent, or by adhesives, depending upon the processing requirements. The adhesives

which have been developed make it possible not only to seal pliofilm to itself but also to bond it to other materials, such as cardboard, chipboard, paper, wood, foil, and metals.

Fiber Glass

INDUSTRIAL AND ENGINEERING CHEMISTRY

FIBER GLASS, recently attracting general attention as multitudes of new uses have been developed for it, has reached its present stage as a result of a long series of mechanical improvements. As far back as 1893, at the Columbian Exposition, according to a paper by J. H. Plummer in the July, 1938, issue of *Industrial and Engineering Chemistry*, workmen were spinning glass by drawing the fibers from a heated rod by means of a drum rotated by a foot pedal. Besides several lamp shades, three dresses (one of which is now exhibited at the Toledo Museum of Art) were made of the fabric which was woven from bundles of coarse glass fibers, each 0.001 in. in diameter, with a filling of silk. Additional silk warp threads were added between each bundle to provide the necessary strength.

The recent history of glass fibers, says Mr. Plummer, dates from the beginning of the World War when the Germans were unable to import asbestos for insulating purposes, and it was necessary for them to develop other materials. The hand process of producing glass fibers was used at first, but later the winding drums were increased in size and driven mechanically. Furthermore, the glass was pulled from orifices in the furnace itself, instead of being first made into rods and spun from them. The resultant fibers were very coarse by present standards and also harsh and brittle.

An important development was made in 1931 when a blast of steam replaced the drum as a means of attenuating the glass stream. This method permitted the continuous production of flexible fibers of any diameter desired within the limits of 0.001 in. and greater. It was no longer necessary to stop the process every few minutes to remove the fibers that had collected. Furthermore, the process was easily controlled and only a few seconds were required to change from the production of fiber of one diameter to that of another. The first fibers made in this way were utilized in an impingement-type air filter used in air-conditioning units.

During the development of the steam-blown process, it was found that the diameters of the fibers produced were intimately related to the viscosity of the glass, the size of the orifices in the tank, and the rate at which the fibers were drawn. All of these factors were under control except the size of the orifices. In the early work these orifices consisted of holes in a refractory block, and, after a few hours of operation, the holes had enlarged so as to require replacement of the bushing. It was not until bushings of precious-metal alloys were used that a constant orifice diameter could be maintained. These alloys permitted the use of smaller orifices and led to the development of a form of glass fiber suitable for service as heat and sound insulation in all types of building construction. By heating the bushings electrically, it was possible to reduce the orifices to very small diameters and still maintain a satisfactory flow of glass which could be accurately regulated by control of the bushing temperatures.

The use of high-pressure superheated steam made it possible to attenuate the streams of molten glass at speeds exceeding the velocity of sound. These high speeds produced much smaller fibers and permitted more rapid production. Almost any type of fiber glass, long or short, coarse or fine, could now be produced by a choice of orifice diameters, working temperatures, and steam pressures. The fibers could be fabricated into many forms such as bats and granules for insulation of houses, blankets of many sizes for industrial purposes, bonded materials for rigid and semirigid insulation, and plastic cements.

The form of fiber glass then produced had the appearance of natural wool, and this resemblance was probably responsible for the idea of developing fiber glass for textile purposes. The first experiments consisted of an attempt to make yarn by passing glass insulating wool through machines used for producing yarn from natural wool. This process proved to be unsatisfactory. About this time a very fine, long-fibered, silky type of fiber glass was produced for experimental work on battery separator plates. This material was made in the form of a laminated mat which, when split into thin layers, could readily be drafted into a heavy sliver. When twisted the slivers or loose strands could be woven on a standard heavy-fabric loom. The weaving of fiber glass was now assured and further progress was dependent upon the development of a forming machine which could produce sliver in continuous lengths, sufficiently light and thin to be drafted into fine yarns.

A machine was designed which consisted of a small electric furnace with a row of orifices in its underside, a steam blower just beneath the furnace, and a collecting conveyer some distance below this. However, this distance was later reduced so that the fibers arrived on a chain as individual filaments and not in clusters. The sliver thus produced represented a considerable advance, but was not yet suitable for drafting and twisting, especially on standard textile equipment.

It was discovered that glass of almost optical quality was required. There could be no seeds or bubbles in the molten mass as these were likely to interrupt the flow by obstructing the orifices. As the quality of the glass improved, it became possible to reduce the diameter of the fibers further, and now uniform fibers only 0.0002 in. in diameter are constantly formed on a production basis, with yarns as fine or finer than silk. During the early development, it was found that a very long-fibered form of fiber glass resulted in a thread having the luster of silk, but when the average fiber length was reduced, this resemblance was lost and the product was then similar in appearance to cotton thread.

With this in mind, engineers developed a process to produce a sliver containing only continuous filaments. By combining the newly developed electrically heated bushing with its fine orifices and the spinning drum, it was possible to form continuous fibers with a diameter of only 0.0002 in. With the proper type of fiber assured, the remaining problems consisted of the development of a means of gathering the fibers into a strand and winding this strand on a spindle so that it could be easily unwound.

Breaking of fibers near the bushing is serious, not because of the loss of one or two filaments but because in breaking they are likely to snap back and break more. Since it may require half an hour for an operator to start all of the fibers properly, the truly efficient operation is one in which no breaks occur. The difficulty has been overcome largely through the use of glass of optical quality, and 102 filaments are pulled at a time at the rate of 6000 ft per min. Experience indicates that this figure may soon be greatly exceeded, although the strands produced today by this process are composed of 102 filaments, each of which is over 12 miles long; the strand itself is little larger than a human hair. From the fiber-producing machines the bakelite spools containing the strands pass to standard textile twisters where the strands are unwound and twisted together into a yarn. Further processing is accomplished with other standard textile equipment, and the sheerest of fabrics may be produced.

LETTERS AND COMMENT

Brief Articles of Current Interest, Discussion of Papers in Previous Issues

His Letter Got Results

To the Editor:

Having received so many replies to my letter which appeared in the August issue of Mechanical Engineering it seems obvious that quite a few engineers are interested in establishing a closer contact with members interested in special machine design.

An interchange of names and addresses of those responding thus far has already been accomplished and it is my hope that this acquaintanceship may result in at least an informal group activity at the A.S.M.E. Annual Meeting.

It is quite likely that the contacts we have made so far may result in an exchange of personal and plant visits which will, no doubt, be beneficial to all of us.

It is my hope that the insertion of this second letter may result in getting in touch with still more people who might be interested in joining with us in this activity.

W. C. Weber.[1]

To the Editor:

In your August issue you published a letter from Mr. W. C. Weber in which he states that at the various meetings of the Society he has not had the opportunity of making contacts with members who are interested in the specialized phases of machine-design activities devoted definitely to the problems of design and development of labor-saving equipment intended as aids to production.

I feel that Mr. Weber has overlooked opportunities existing in the A.S.M.E. Materials Handling Division in this respect. Many of the members of this division are devoting their efforts to the design and development of the type of equipment which he mentions. While conveyor systems may not be strictly classified as production machinery, yet the problems involved in the mechanical handling of materials are definitely connected with the more specific problems of production. In many cases it is difficult to differentiate between the handling and production phases of certain operations, and in fact, the two processes often occur simultaneously.

Conveyor and other material-handling systems are definitely labor-saving aids to production and it is my opinion that in the Materials Handling Division of our Society Mr. Weber will find many members whose interests and activities run along the lines which he has in mind.

Allan P. Stern.[2]

[1] Chief Engineer, in charge of mechanical development department, Corning Glass Works, Corning, N. Y. Mem. A.S.M.E.

[2] Vice-President, The Colonial Iron Works Co., Cleveland, Ohio. Jun. A.S.M.E.

Measuring Composition of Flue Gas

To the Editor:

I wish to take exception to the statement by Mr. Louis Elliott in his letter to the editor appearing in your "Letters and Comment" section of the August issue of Mechanical Engineering.

Mr. Elliott makes the statement: "It is recognized . . . . that no complete and satisfactory tests have as yet been worked out for determining losses resulting from presence of carbon monoxide and unburned hydrocarbons."

The writer assisted in developing apparatus and technique for the purpose of accurately determining the quantity of unburned hydrogen, hydrocarbons, and carbon monoxide occurring in the boiler flue gas. This apparatus is now used to the exclusion of the familiar Orsat apparatus for determining the proper excess air and setting of the Bailey boiler meters at the Hudson Avenue Station.

The development of this apparatus resulted from the conviction that "the unaccounted-for" item in boiler heat balances was largely due to the inadequacy of the Orsat to give more than a rough indication of flue-gas composition. It was also suspected that the assumption, that absence of carbon monoxide precluded the appearance of hydrocarbons, was untenable. Results obtained during a comprehensive test of one of the late boiler installations at Hudson Avenue fully justified the use of the new apparatus. The "unaccounted" item practically disappeared as was expected.

The foregoing equipment and tests were fully described in the papers, "Test Performance of Hudson Avenue's Most Recent Steam Generating Units,"[3] by P. H. Hardie and W. S. Cooper, and "Analysis of Combustibles in Flue Gas,"[4] by R. N. Evans and J. E. Davenport.

W. S. Cooper.[5]

Practical Applications of Motion-Study Research

To the Editor:

I am glad to note that Professor Barnes[6] stresses the value of motion study on inspection operations. As we go through the factory reducing the productive labor cost, our nonproductive-to-productive ratios begin to grow until they eventually get out of line. It is necessary to extend motion study to the entire organization and particularly to such operations as inspection. Those of us who have gone into inspection have found it to be a gold mine for motion-study applications.

Inspection involves a great many hand motions. Material must be transported into a convenient position for visual inspection, and then disposed of into a tote box or shipping case. Often by making a simple change, merely using both hands simultaneously instead of only one hand, savings of 10 or 15 per cent can be made. The investment in tools and fixtures is small.

The visual element in inspection is fast, and at times the inspection can be done while the pieces are in transit, thereby permitting a combination of an inspection and an assembling operation. For example, on one of our jobs we were assembling washers to a small syringe part and then making a separate visual and gage inspection. All three items were combined so that the visual inspection was made while positioning the

[3] Published in A.S.M.E. Transactions, 1934, vol. 56, paper FSP-56-15.

[4] Published in *Industrial and Engineering Chemistry*, 1935, vol. 7.

[5] Assistant Engineer, Test Bureau, Brooklyn Edison Company, Inc., Brooklyn, N. Y. Mem. A.S.M.E.

[6] "Practical Applications of Motion-Study Research," by Ralph M. Barnes, Mechanical Engineering, May, 1938, pp. 395–400.

pieces for assembly, and the assembling and gaging were done simultaneously.

Another idea is to substitute manual gaging for visual inspection. For example, we were checking the thickness of hard-rubber strips and it was necessary for the operator to watch the needle of the dial gage. A special gage was rigged up through which the pieces are pulled. Oversize strips jump out of the maximum gage and undersize ones drop into the minimum gage and are rejected.

In one case where inspection was necessary prior to a packing operation, the visual element of the inspection was short, but the pieces were handled twice. It was found possible to position the pieces during the packing operation so that the visual inspection could be made without interfering in any way, with the speed of packing. This saved most of the inspection cost, as it required only a small amount of time to glance at the pieces when pre-positioned.

In another case it was possible to have the inspector assemble two pieces in a closed assembly. In the old method the operator assembled and later the inspector had to reopen the assembly, look inside, and then close it again. Unnecessary motions have been eliminated by combining the operations. Similarly, many combinations of assembling and testing can be made in which the inspector does the assembling, combining it with the testing and visual inspection. Numerous "get ready's" and "asides" are eliminated by these combinations.

Another problem in connection with inspection is the one-armed inspector. By introducing holding devices to position and mount the gages or testing devices, it is possible to free both hands to move the pieces, thereby stepping up production from 10 to 15 per cent without any sacrifice in quality. Numerous aids to counting can also be rigged up by using racks or stands which will predetermine the count, thereby insuring greater accuracy and better workplace arrangement.

In many cases it is possible to do things in multiple, such as using racks and holding devices for turning a number of pieces over to inspect the other side.

The principle of drop delivery is often applied to inspection, unless the articles are too fragile to be handled in this manner. Even fragile articles are often handled through cloth drop-delivery chutes or chutes with cloth flaps at the bottom to break the fall.

I am also glad to see that Professor Barnes stresses the importance of sliding objects wherever possible, instead of picking up and carrying them. We had an interesting problem on our drill presses that was solved through the use of the sliding principle. For several years, successive motion-study classes tackled the problem of drilling a small hard-rubber article about the size of a quarter. This article was drilled one at a time and the operators had developed tremendous speed, rhythm, and automaticity. They laughed at any attempt to substitute a two-handed method. Finally, one class group working on this problem, introduced the sliding principle and showed a 30 per cent saving over the old one-hand method, at the same time eliminating an accident hazard. Result: a safer job at a lower cost.

Professor Barnes' report on differences in assembly time due to the shape of the ends of pins and the amount of taper on bushings, confirms our observations in the factory. One particular case is that of slipping uncured rubber tubes on small-diameter mandrels. We found out that a bullet-shaped nose shortened the time for positioning, thereby reducing the total time for inserting the mandrel in the tube. As a result, we put a bullet nose on over 100,000 mandrels.

The experiments on the 45-deg bevel are interesting and suggest the redesign of drill fixtures and jigs for mass-production work. Any slight hesitancy due to positioning or locating, will increase the operation cost. Positioning delay can frequently be detected by watching the operator, but sometimes the camera is needed to prove it definitely.

There is plenty of evidence that motion-study research will be of great help to industry. It should aid us to eliminate unnecessary effort and, by increasing production per man-hour contribute toward the betterment of our standard of living.

W. R. MULLEE.[7]

Trends in Shop Practice and Drafting

TO THE EDITOR:

I am much interested in Mr. Bond's excellent paper[8] on the new types of machine tools and the changes in method of dimensioning drawings, making them more applicable to direct use on these machines. I am sure that engineers are desirous of issuing drawings and other manufacturing information to the manufacturing department in a manner which will enable the workman to manufacture the apparatus with the least effort on his part, and so that the parts produced may be such that there is a minimum of rejections for one reason or another. Extra operations, loss of time, and rejections naturally increase the cost of the product and obviously the engineer is definitely concerned in the cost of his product.

The paper has demonstrated clearly the necessity of a change in our practice of long standing of dimensioning drawings. The problem, as it appears to me, is not one of whether this is a wise thing to do, as apparently there is no question in that respect, but one of how the job is to be accomplished. In manufacturing organizations where the nature of the product is along similar lines, the problem is less complicated than in organizations where there is considerable diversification; therefore, in my opinion, the subject has to be approached carefully and perhaps slowly, and the change can only be accomplished in either case through close cooperation between the manufacturing and engineering departments. The progress in the improvement in design of machine tools is so rapid, and, no doubt, will continue to be so, that without this cooperation it is practically impossible for a large engineering organization with considerable diversification in product to keep fully informed about new equipment. The best way to accomplish the desired result would be to make a definite setup of contact between these two departments so that instances where economies could be obtained by redimensioning existing designs could be called to the engineers' attention. In the development of new designs the best method of dimensioning could be discussed and the drawings issued originally in the best form for economic production.

T. G. CRAWFORD.[9]

TO THE EDITOR:

I wish to congratulate Mr. Bond on an excellent presentation of an important problem in the relations of design and manufacture and heartily to endorse his plea for a closer understanding of shop developments by design and detail draftsmen.

The machine tools described in the first part of the paper are typical of good results obtained by cooperation between the machine-tool manufacture and user. Combinations of precision screws, scales, dials, modern shop optical instruments,

[7] Supervisor, Standards Dept., American Hard Rubber Company, Butler, N.J. Jun. A.S.M.E.

[8] "Trends in Shop Practice and Drafting," by W. L. Bond, MECHANICAL ENGINEERING, July, 1938, pp. 545–549.

[9] Engineering General Department, General Electric Company, Schenectady, N. Y. Mem. A.S.M.E.

and multiple motor drives with remote control present many opportunities for reducing layout time and simplifying drawing work. Other applications we have made are front-operated precision motor-driven back gages on squaring shears and bending brakes, and adjustable group piercing dies and quick-locating devices on punch presses.

The turret punch press in Fig. 5 is particularly valuable in work on steel switchboard panels both in reducing shop- and drafting-layout time as well as in improving uniformity of product design.

I should like to make some comments on drawing practice and particularly on Figs. 7 and 11 of the paper. In general, I believe our present shop drawings give much more information and give it in more convenient form than those of ten years ago. At the same time, standardization of arrangement, detail parts, materials, treatments, and processes and concentration on essential information have permitted this to be done without increase in drafting time. Our drafting rooms try to give the shop the information they want. If we have not dimensioned a part to the satisfaction of the machining section, we add the required dimensions at the request of the shop.

We have not found it desirable to eliminate angular dimensions in favor of linear, in all cases, and I do not think that Mr. Bond intended to convey this impression. If a bracket is bolted to a motor frame we use the same system of dimensioning for both frame and bracket. Where holes are equally spaced we usually use radius and angle, or radius and chord for this type of dimension.

On lamination punchings, as illustrated in Fig. 7, we would stick to the radius-and-chord method where the punching is a complete circle.

On the shaft in Fig. 11 our practice is to give undercuts as a direct width measurement and dimension only one side of the undercut from the base line. The workman can then select the correct standard width of undercutting tool without calculation. We also give a separate dimension with tolerances for journal shoulders, independent of the base-line dimensions. On this type of drawing, machining dimensions are placed on one side of the horizontal center line and engineering-reference or assembly dimensions are placed on the other side of it.

In dimensioning castings it is important to consider foundry practice and locate and dimension so that variations caused by parting lines and core prints will not cause cover plates to be misplaced. Strict adherence to *X-Y* base lines would cause this to occur.

I should like to mention several other opportunities for the drafting room to help the shop. In sheet-metal work where boxes or cabinets are being made with a range of sizes, it is frequently possible to make corner radii, fold-over dimensions, and spacing of holes standard for the entire line. This permits use of a single set of radius bars, brake stops, and multiple piercing dies to be kept set up with little or no change-over time from one size to another.

Hole layouts can frequently be simplified to reduce the number of sizes of drills and taps and therefore the number of spindles and setups required. There is little difference in cost of screws, nuts, or rivets in the sizes between $^1/_8$ in. and $^1/_4$ in. and frequently a design can be made with all screws No. 10 instead of Nos. 6, 8, and 10. The three sizes of screw holes mean setting up three drill spindles for tap-size drill, three spindles for tapping, and, in the corresponding piece, three spindles for clearance holes and sometimes three more for counterboring or countersinking, a total of nine or twelve instead of three or four. Even in small-quantity production this extra setup is a large factor in cost, requiring three sizes of bushings in the drill jig itself, more time for setup, more power for the extra six or nine spindles while the work is going through the shop, extra labor because the operator must walk along a gang of drills instead of standing still in front of a one-, two-, or three-spindle machine, three containers and specially bladed screw drivers on the assembly bench, and extra time to insert screws. It may represent several thousand dollars in extra drill spindles tied up during operations on a small quantity or continuously invested in a straight-line setup. Even if multiple drill heads are used, most efficient speeds will probably not be possible for all sizes and the assembly and stock difficulties remain.

It is frequently possible to reduce the number of directions from which a piece must be machined without reducing efficiency of design or marring appearance. Setscrews and other auxiliary holes should be placed in the same plane as other essential holes instead of at a separate angle, and pads at right angles to the base or other machined surface where possible.

Finally, I wish to emphasize Mr. Bond's points on the necessity for close contact and cooperation between the drafting room and the shop. No method of machining or finishing is necessarily correct or lowest in cost today because this was true yesterday. Machine-shop practice has made great strides in the past few years and drafting-room practice must be alert to move with it.

A. F. Murray.[10]

Fuels for Industrial Heating Furnaces

To the Editor:

Mr. Mawhinney has covered so much territory in such few words that his paper[11] could easily be used as an outline for a course of study on fuel selection. By using it as a guide and thoughtfully following out the indicated development tendencies to their logical conclusions in each individual case, it seems that a great deal of difficult and expensive remodeling of furnaces could be avoided. A furnace or process using the correct fuel as indicated by a complete and exhaustive survey of the local fuel situation and the general advances in the industry should serve for a long time without becoming obsolete and costly in the light of new developments. In other words, what may seem like a radical and almost fanciful application at the present may be the very thing that will be commonplace tomorrow and the user who has had the foresight to keep ahead of such development will surely be able to keep his operating costs well below the average of his industry.

One of the things that forcefully strikes the reader is the fact that furnace design entails many problems of which fuel selection is only one, and it is evident that the occasional furnace buyer is not fitted to determine for himself the best equipment to use. This explains the rapid and vigorous growth of the industrial-furnace organizations which offer the occasional buyer of furnaces a service he would have a hard time duplicating anywhere else. It is also evident that these organizations must continually do a vast amount of research work to keep abreast of the rapid development not only in heat applications but in the various processes to which these applications may be made.

Although the paper only touched on the importance of burner and control equipment a great amount of time could be given to even a partial discussion of either of these phases of industrial furnace design. In the past the tendency has been for the control engineers and the

[10] Manufacturing Engineer, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. Mem. A.S.M.E.

[11] "Fuels for Industrial Heating Furnaces," by M. H. Mawhinney, Mechanical Engineering, May, 1938, pp. 381–384.

burner designers to go their separate ways without much regard to the activity of each other. Fortunately for all concerned, that tendency is disappearing and as a result the development of combinations of control and combustion equipment to accomplish a desired end has gone forward much more rapidly.

In addition to the developments in control and burner equipment, should be mentioned the tremendous and radical changes in the characteristics of the refractory and insulating materials available for furnace construction now as compared to only a few years ago. Not only improvement in regard to the temperatures that may be safely and continuously carried by various new refractories but also the development of materials possessing the advantages of both high refractoriness and of good insulating properties and correspondingly small heat-storage capacity have made necessary many changes in furnace design. Smaller furnaces with lighter walls, considerably reduced heat requirements, and much higher over-all efficiencies have been made immediately possible. The effect on heating cycles especially of batch-type furnaces has been remarkable and is only now beginning to be generally appreciated.

Mr. Mawhinney's outline of future trends in fuel technology is interesting and, substantially correct. However, it is believed that the trend toward the use of combinations of fuels is one that should not be overlooked. In other words, instead of attempting to produce all the necessary heat and atmospheric effects in each installation by using only one fuel, several fuels will be used in different parts of the same furnace to secure easily the different results desired. This trend will be accelerated by the development of alloys that will stand higher temperatures and be suitable for muffles and tubes.

Another trend that will have an important bearing on furnace and process development and also on fuel selection will be the increasing importance of automatic and protective equipment. As furnaces are considered more and more as industrial tools that must fit into the production line, requirements for protective devices to prevent accidents in case of improper handling become more evident.

There is a marked absence of vague and indefinite generalities that is refreshing in a paper of this kind, and a surprising amount of useful and comparatively detailed information is included.

D. A. CAMPBELL.[12]

[12] Combustion Dept., Eclipse Fuel Engineering Company, Rockford, Ill.

Inspection Methods in Industrial Plants

TO THE EDITOR:

The content of Mr. Bausch's paper[13] is of great interest to all divisions of industry; but to one who has been associated with the problems of the manufacturing division, and has only too frequently encountered what he could not help but feel was somewhat of an arbitrary and uncompromising attitude on the part of other divisions concerned with standards of quality, the concept of counsel, reason, adjustment, and compromise expressed by this paper is indeed gratifying.

Of the many interesting points and basic truths brought out by Mr. Bausch, it is believed that none is of greater fundamental importance than his idea of the development of standard of quality. He asks the question, "How good should we make our product?" and then proceeds to show that neither the engineering division, the manufacturing division, the inspection division, nor the sales division can be the sole arbiter of such a question. A standard of quality is not something that springs forth full-grown like Minerva from the head of Jupiter, but a matter of gradual development based upon ideas arising in the various divisions and clarified and sifted by mutual council and discussion. Thus it is that standards can be established which are most economic, i.e., standards of product which yield a maximum in useful results for a minimum of cost.

There is a valuable idea which might be considered as a corollary to standard of quality, which I would like to illustrate from my own experience, but in doing so I shall have to differ with Mr. Bausch with regard to his attitude toward the rôle of the method of mathematical approach in a field where variables are many. It therefore appears appropriate that the sole point of difference should first be clarified.

Mr. Bausch says that a mathematician would probably be disappointed as no attempt has been made to derive exact and statistical laws for the guidance of the inspector. The remark may apply in all truth to a pure mathematician interested only in the abstract; but it is not believed for a moment that a mathematician properly adapted to his industrial rôle would desire any such thing.

The actual mathematics employed is probably less important than the attitude of mind which the mathematician brings: the attitude of painstaking, logical, and scientific analysis; the attitude of care and persevering application. The practical man is going to use the mathematics in one form or another whether it be called mathematics, statistics, or common sense. He cannot intelligently follow his blueprint without it. The mathematician, if he be a mathematician properly adapted to his industrial rôle, merely shows him how to come to his good common-sense conclusions more quickly and efficiently. Nor does the usefulness of statistical approach diminish with an increase in the number of variables. A multiplicity of variables quickly leaves the cut-and-try methods in a state of confusion, but has the contrary effect on statistical methods. The larger the number of systems of chance causes, the more readily and precisely the statistical method applies. I have found it so in working with ammunition, and Dr. Shewhart has ably demonstrated the reasons for this condition.[14]

In the light of these observations, then, I would like to illustrate the suggested corollary to Mr. Bausch's standard of quality. In the manufacture of a certain piece part for an antiaircraft time fuse, the specification required a powder charge of 30 grains plus or minus 2 grains. The method of volumetrically weighing out these charges did not yield all products within these limits. As a consequence, 100 per cent inspection was required, just as was the case with the bifocal lenses. Even with 100 per cent inspection, complaints about variations in quality were received. An analysis was made of the causes of variation following the methods of Dr. Shewhart's book, the essential working principles of which are concisely covered in the "1933 A.S.T.M. Manual" prepared last year under the joint committee of The American Society of Mechanical Engineers and the American Society for Testing Materials. In making this analysis data were compiled showing the average and variation, similar to the case of the data on bifocal lenses. However, the data were broken down into short periods of time and presented graphically. Immediately upon the observation of a significant variation in average or amplitude of variation, an investigation was made of the probable cause. The cause could frequently be located because the data were arranged according to short periods of time. As a consequence of this investigation some of the major causes of variation were discovered and eliminated. A new volu-

[13] "Inspection Methods in Industrial Plants," by C. L. Bausch, MECHANICAL ENGINEERING, July, 1938, pp. 553–556.

[14] "Control of Quality of the Manufactured Product," by W. A. Shewhart, D. Van Nostrand, Co., New York, N. Y. 1931.

metric machine was made which did not have many of the faults inherent in the older ones, and it was found possible to hold the variation within plus or minus $^1/_2$ grain. As a consequence of this accomplishment it was possible to abandon 100 per cent inspection. It was only necessary to set the machine at a satisfactory level and then make periodic percentage checks to see that neither the average level nor the variation appeared to have changed beyond the control limits. This method reduced the cost of this operation by 85 per cent, and produced a product with a uniformity of plus or minus $^1/_2$ grain, instead of plus or minus 2 grains as before. As a result of the procedure a running record was kept in the form of a control chart which was an authentic guarantee of the quality of the product.

Of course, it is by no means possible to do this sort of thing in all instances. Where the natural limits of control cannot be reduced to sensibly less than the tolerance limits, 100 per cent inspection is inevitable. Ample illustrations could be cited. Others could be cited parallel to Mr. Bausch's, where other divisions relaxed their requirements in order to allow the manufacturing division to proceed on a more economical basis. Nevertheless, the example is believed of merit because it shows how the manufacturing division (which is usually inclined to cry for more tolerance) can, at least occasionally, both reduce the cost of manufacture and materially raise the standard of quality, through the use of statistical analysis.

Leslie E. Simon.[15]

To the Editor:

The author's comments on precise accuracy and his statement that it is theoretically impossible to effect exact duplication in any product are, of course, correct, but in most of our industries we are more interested in practical duplication in our various products within the range of our micrometer measurements. Allowable tolerances of as little as one ten-thousandth of an inch are used, but in most cases one thousandth of an inch is considered commercially adequate. I have particular reference to various articles in mass production in American plants, for it is in these great plants, particularly in the automotive industry, that extreme accuracy becomes a real necessity. To produce an article economically in large quantities there must not be any hand fitting, dressing down of surfaces, or any other type of interruption to rapid assembly.

I believe that the inspection department of a plant should be closely allied with the engineering department, preferably operate under the chief engineer, and be permitted to report jointly to engineering and management.

Of course, the department should have inspection equipment of the proper design and accuracy to enable it to do the required job. It is also necessary that the inspectors doing the work be fine technicians, preferably with experience in the factory. A chief inspector, in my opinion, should be technically trained, preferably an engineer with a metallurgical background.

In the interests of good manufacture I believe that, if it is discovered that the product is defective on the production line, the line or the whole department should be shut down until such defect is remedied. Not a single piece of the defective material should be allowed to get out. Even if such a policy means closing the entire plant. While such action sounds drastic, the effect is far-reaching. In the first place, it keeps the manufacturing department alert and guarding against such mistakes. Secondly, when this policy becomes known to the sales department and the trade, it can be capitalized to great advantage.

When I was appointed chief engineer of the Lincoln Motor Car Company by Henry Ford he stressed the point that the plant should be shut down if necessary when inspection reported any serious mistakes occurring in production, at the same time reciting his own experience in this direction. One morning his attention was drawn to trouble in his cars, called vapor lock, caused by the boiling of gasoline in the carburetor, and resulting in lean missing of the engine. He walked down the final assembly line and noticed that the copper gas line was actually touching the exhaust pipe. He of course ordered it corrected. He ordinarily checked an order of this kind later but as he was called to another plant did not return until the next morning when he was astonished to find cars still coming down the line in the same condition. He called the superintendent and told him to shut down the plant and send all the men, 50,000 of them, home. The superintendent tried to explain that pipe-bending fixtures had to be changed and that cars would soon be rolling down the line with this defect corrected but Mr. Ford was adamant. That was the last time an order of his was not instantly obeyed. Sometimes ludicrous and unaccountable mistakes will occur even in the best regulated families. In the Lincoln plant more inspectors are employed, in relation to the number of cars produced, than in any other but we were greatly chagrined one day to receive a sarcastic communication from Australia, asking why we shipped a custom-body job with three red wheels and one black one.

Thomas J. Litle, Jr.[16]

To the Editor:

I wish not to take exception to Captain Simon's comments on my paper, but rather to accept them as a valuable addition. I, in my statement, did not intend to belittle the mathematical approach to the subject of inspection, but rather to apologize for not being able to supply such methods in practice to my particular problem. I believe that volume of product and number of variables for which it is necessary to inspect will determine the extent to which the rigid mathematical solution can be used in inspection problems.

Carl L. Bausch.[17]

Courtesy Allis-Chalmers

[15] Captain, Ordnance Department, U. S. Army, Aberdeen Proving Ground, Md.

[16] Chief Engineer, Easy Washing Machine Corporation, Syracuse, N. Y.

[17] Vice-President in charge of engineering, Bausch & Lomb Optical Co., Rochester, N. Y. Mem. A.S.M.E.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Machine-Tool Design

Die Werkzeugmaschinen, Grundlagen, Berechnung und Konstruktion (Machine Tools, Their Principles, Calculation, and Design). By G. Schlesinger. Julius Springer, Berlin, 1936. Fabrikoid, $7^3/_4 \times 10^5/_8$ in., 2 vols.; vol. 1, 818 pp., figs., tables; vol. 2, 52 supp. plates. 147 rm.

Reviewed by Dr. M. Kronenberg[1]

IN THE introduction to his work, Schlesinger says that it has been his intention by publishing this book to unite practical experience, research, and instruction in the field of machine tools in order to put the design of machine tools on a scientific basis. It must be admitted in advance, that this aim has been reached. There is no book on machine tools all over the world that may be compared with this one. It is an outstanding and unique work.

It is a matter of fact, that the design of machine tools has, in the past, been largely based on experience and tradition, rather than on the determination of the forces and of the moments of bending and torsion, as is the case in other fields of machine design. Before the publication of Schlesinger's book literature was lacking which deals with machine tools in such a manner as to permit the designer to obtain information for the calculation of deflections, stresses, etc. The sections which deal with these subjects justify the statement that this book gives information which can be found nowhere else.

Chapter 1 deals with the forces, the speeds, and tool life involved in turning, drilling, milling, grinding, planing, broaching, pressing, drawing, and forging. The values given are based on Schlesinger's tests, which were carried out during the 30 years of his former association with the Berlin Technical University, as well as on comparisons with tests of American and English origin. The values are given in a generalized manner, so that they are not a mere accumulation of results of different tests from all parts of the world which cannot be utilized, but are brought into a scientific system. This permits of obtaining a complete understanding of the various interrelations and provides answers to practical problems.

[1] The Cincinnati Milling Machine Co., Cincinnati, Ohio.

The second chapter refers to the economical utilization of machine tools and gives examples for different kinds of machines.

The third chapter is devoted to means for producing rotary and reciprocating motion. Here we find extensive information about the arithmetical, geometrical, and logarithmical progression of speeds; we learn about the fundamental work which Schlesinger has done in connection with the standardization of the rpm of machine tools in Germany, and which is now generally adopted over there. He not only considers the conditions for "standard revolutions" in connection with German motor drives, but also in connection with American motors. The standardization of revolutions resulted in the development of standards for gear drives which permits of an easy method for the determination of the number of teeth of the gears and their center distances, a method which avoids the laborious approach hitherto used. Stepless drives—mechanic, as well as hydraulic and electric—are furthermore dealt with, both for rotary and reciprocating motion, and many examples are given with detailed calculations.

Chapter 4, which together with chapters 1 and 3 appears to be the most outstanding, opens a new field for every engineer interested in machine tools. Based on tests and on scientific deductions, Schlesinger gives a complete picture of the methods for the determination of stresses and deflections for such complicated structures as occur in machine tools. This chapter reveals the superiority of Schlesinger's pioneer work. With utmost thoroughness the following cases are investigated: Deflections and stresses in various planes and sections through a lathe, a drilling machine, a radial drill, a horizontal milling machine, a vertical milling machine, a planing machine, and different presses. The same chapter embraces furthermore guideways, bearings, lubrication, clutches, gears, belt drives, and chain drives with respect to their application and design for machine tools.

Chapter 5 deals with complete calculations for the construction of machine tools. Various examples are calculated so that the designer is guided and advised from beginning to end.

In the concluding chapter, 6, which comprises nearly half of the first volume, examples of many different types and makes of machine tools are shown and described in detail. These include American, German, Belgian, and English designs.

The second volume contains 52 drawings of the drives of machine tools with a new method of designating the sequence in which the power is transmitted through the machine.

It would be useful to have an English translation of this book, possibly published in condensed form. In this case those chapters should be chosen which deal with fundamentals, i.e., chapters 1, 2, 3, 4, and 5 and which will therefore not soon become out of date. With an English translation the American machine-tool engineer would be provided with a text and reference book of inestimable value. This book is unquestionably the masterpiece of the world's outstanding authority on machine tools.

Isaac Newton

Isaac Newton, 1642–1727. By J. W. N. Sullivan. With a memoir of the author by Charles Singer. The Macmillan Company, New York, N. Y., 1938. Cloth, $5^3/_4 \times 8^3/_4$ in., 275 pp., $2.50.

IT IS now more than two hundred years since Isaac Newton died, full of years spent to the glory of God and in the service of science and his country. For two hundred years his influence and the usefulness of his discoveries, particularly in mechanics, kept his name at the top of a glorious list of those responsible for the spectacular growth of science that flowered so brilliantly during the industrial revolution. His name is known to all. Voltaire's story of the famous apple, which he is said to have heard from Newton's niece, Catherine Barton, has been retold to many generations of school children. Voltaire's tribute, in assenting to someone's estimate that Newton was the greatest of men—"for it is to him

who masters our minds by the force of truth and not those who enslave them by violence, that we owe our reverence"—is echoed by many.

Newton was a genius whose life presented more than the usual number of paradoxes. No influence of heredity can explain his mental powers. He overthrew many of the scientific theories of his time, yet he worked assiduously on a chronology based on Ussher's date of 4004 B.C. for the Creation. He devoted much time and study to theology and biblical interpretation, yet he was ready to resign his university post rather than take priestly "orders." He professed to shun human contacts, yet served brilliantly as Master of the Royal Mint. He formulated the laws of universal gravitation and mechanics that served satisfactorily for two centuries as a result of studies that occupied only a small fraction of his time, yet he spent years in the elusive field of alchemy, without results. He claimed to be free from a priori bias in his reasoning, yet he founded a system of mechanics on Euclidean geometry. He was so careless of his original work that he let it lie for years unpublished and unheeded, on scraps of paper, yet he engaged in long controversies over charges of plagiarism in which this work was involved. And finally, as Mr. Sullivan remarks twice in his biography, "The paradox of Newton's scientific career is due to the fact, probably unique in the history of scientific men, that he was a genius of the first order at something he did not consider to be of first importance," for time and again he announced his lack of interest in scientific work.

Mr. Sullivan's biography, published shortly after his death, shows Newton the man against the background of his time, and the seventeenth century was a time of growth and change. Politically, in England, it brought the Commonwealth, the restoration and the end of the Stuarts, and the reign of William and Mary. It brought the "plague" and the "Great Fire." It was the time of Milton and Pepys, of the terrible Jeffreys, before whom Newton at one time was forced to appear, of Wien and Locke and Robert Boyle, of Huyghens, Leibnitz, and the Bernoullis. It saw the founding of the Royal Society as a result of intellectual stirrings that were expressed by its first secretary in the words, "Let us set sails of true knowledge, and search more deeply into the innermost parts of Nature than has been done hitherto." It was a time when men tried to throw off the deadening influences of the past and apply a new method of objective inquiry, come what might of established thought. It witnessed an intense interest in philosophy and theology, and the struggle of orthodoxies, that held men in a powerful grip, with doubts and revolutionary ideas certain to be branded as heresy. It gave birth to the gradual substitution of the scientific method for a priori reasoning based on the assumption of hypotheses to be demonstrated. The accepted method of today—research— was largely untried, scorned, condemned, and, it must be added, not understood. Only a few, like Isaac Newton, sensed its value and made use of it.

All this Mr. Sullivan makes abundantly plain in the broad sweep of his biography, and against this background there emerges the figure of a man whose scientific work, which he apparently considered of little importance, has vastly overshadowed human qualities. We have thought of Newton in terms of gravitation, of his laws of motion, his "Opticks," his telescope, his "Principia," his fluxions, his controversies over plagiarism, his theory of light, grossly misrepresented by his disciples, according to Mr. Sullivan. Without detracting one whit from the glory which these achievements shed upon Newton, Mr. Sullivan looks inside of this monumental structure of physical science and discovers the quiet, introspective, mild-mannered student, who wanted most of all to be let alone, and who frequently expressed his annoyance at finding himself a "slave to philosophy" when he preferred to concern himself with other matters.

Mr. Sullivan makes much of Newton's aloofness, and is at pains to find an explanation for it at several places in the biography. "There is plenty of evidence . . ." he says, "that Newton's unemotional aloofness was largely the result of self-discipline, although he doubtless found this discipline unusually easy to acquire." He goes into the subject of Newton's "mental derangement," which he connects with the death of the scientist's mother, and says of it that it "consisted not in an enfeeblement of his powers, but in a loosening of his control." Other factors are considered—the fire purported to have destroyed work on which he had spent much labor, the reaction to the concentration required for the composition of the "Principia" in seventeen months, his experiences in London and the influence of worldly persons, failure of his friends to obtain at that time a political appointment for him, coupled with a resentment that he should be dependent on the patronage of aristocrats and politicians, and Newton's own explanation—sleeplessness. And of Newton's wholly unjustified accusation in a letter to Locke "that you have attempted to embroil me with women," a clear evidence of the "mental derangement," Mr. Sullivan says: "If we assume that Newton's remark had no basis in fact whatever, then the fact that this particular fear emerged during his period of lessened self-control indicates that his life-long celibacy was not achieved without self-discipline."

Newton's controversies with Hooke, with Flamsteed, and with Leibnitz and John Bernoulli run throughout the book as they did off and on throughout the man's life. None of these disputants is painted by Mr. Sullivan in pleasing colors. "Hooke resents Newton's intellectual superiority," says the biographer. "Newton resents the attack on his moral integrity. To Hooke, Newton was a rival; to Newton, Hooke was a nuisance." Flamsteed, the first Astronomer Royal, is characterized as a man whom Newton must have conceived as a "fussy bore." Much is made of Leibnitz' attempt to prove Newton an atheist. Bernoulli is represented as having told a deliberate lie. But whether or not these men were as they here appear, the reader can hardly escape the impression that Newton must have been an exasperating person to deal with in a controversy, for apparently, unless his personal integrity was attacked, he just didn't pay any attention to those who annoyed him.

Following the illness, or "mental derangement," which occurred sometime between 1691 and 1693, Newton's mode of life suffered a complete change. In 1696 his friends had been successful in securing for him the appointment of warden of the Royal Mint. He forsook the quiet retirement of Cambridge, where he had been practically free to conduct such studies as suited his mood and the spurs of his driving genius, and went up to London. This was not his first experience among the worldly, for in 1689 he had been a member of Parliament, representing Cambridge, a reward which had come to him for his active part in riding in the defense of the university when James II issued a mandate that the Benedictine monk, Father Alban Francis, should be admitted a master of arts without the usual formalities. It is said that Newton's chemical and mathematical knowledge was particularly useful in the task, as warden of the mint, of carrying out a recoinage, greatly needed at the time; and in 1699, with this important task completed, he was advanced to full mastership, a position he held until his death.

The last chapter of Mr. Sullivan's book is an appraisal of the influence of New-

ton's work and the effects on its validity of modern physics. Here we are brought face to face with the inevitable changes wrought by the evolution of knowledge. What physicists hold today to be scientific truth may not correspond with what Newton led the men of his time to believe, but Newton's intellectual stature does not grow less because of this. He remains one of the world's great geniuses, whom Mr. Sullivan's unusually readable book presents to us in a fascinating manner.—G.A.S.

Lehigh, Class of 1891

50-YEAR BOOK, LEHIGH, 1891. Edited by H. T. Morris, Times Publishing Co., Bethlehem, Pa., 1937. Fabrikoid, 6 × 9 in., 329 pp. and index, illus., $5.

IN THIS book, which was planned by the class of '91 after seeing the efforts of the class of '89 under the editorship of John Joseph Lincoln, the reader is projected back to the year 1887 when 121 young men entered Lehigh University as freshmen, bubbling over with enthusiasm and anticipation of the future.

In the class of '91 was A. G. Croll, H. T. Morris, and R. P. Stout, who are or have been members of the A.S.M.E. In addition to these, mention is made of a number of other mechanical engineers, some of whom hold or held membership in the Society, namely, Frank B. Bell, R. M. Bird, William A. Cornelius, W. C. Dickerman, John Fritz, Eugene G. Grace, Archibald Johnston, Joseph F. Klein, one of the first mechanical-engineering professors at Lehigh, Fred V. Larkin, R. A. Lewis, C. R. Richards, W. F. Roberts, and Charles M. Schwab, chairman of the board, Bethlehem Steel Corporation. Both John Fritz and Charles M. Schwab served the A.S.M.E. as president.

Books Received in Library

AIR CONDITIONING, Heating and Ventilating. By J. R. Dalzell and C. L. Hubbard. American Technical Society, Chicago, 1938. Cloth, 6 × 9 in., 571 pp., illus., diagrams, charts, tables, $4. A practical treatise on the principles and general application of steam, hot water, vapor, vacuum, and forced air for heating; split systems for heating and ventilating; and air conditioning for all types of buildings. Calculations have been made as simple as possible, and a profusion of diagrams, tables, and practice problems increase the utility of the book.

AIRPLANE STRUCTURES. Vol. 2. By A. S. Niles and J. S. Newell. Second edition. John Wiley & Sons, New York, 1938. Leather, 6 × 10 in., 177 pp., diagrams, charts, tables, $2.75. This volume of the new edition comprises two chapters which were crowded out of the first volume by new material. These chapters deal with detailed methods for the analysis and computation of statically indeterminate structures and beam columns. They have been revised and expanded.

AIRCRAFT YEAR BOOK for 1938. Edited by H. Mingos. Twentieth edition. Aeronautical Chamber of Commerce of America, New York, 1938. Cloth, 6 × 9 in., 518 pp., illus., diagrams, charts, tables, $5. This annual provides a record of developments in aviation during the past year, both at home and abroad. The work of the army and navy, the activities of the various Federal agencies and commercial firms are reviewed. Chapters are devoted to notable flights, to air lines, private flying, airports, to novelties, and other fields of interest. The book includes tables of aircraft specifications, descriptions of aircraft and engine designs, a chronology of events and records, an aeronautical directory, and statistics of the industry.

APPLIED THERMODYNAMICS. By V. M. Faires. Macmillan Co., New York, 1938. Leather, 6 × 10 in., 374 pp., illus., diagrams, charts, tables, $3.90. An elementary textbook covering the theories of thermodynamics involved in engineering problems. It includes the material contained in the author's "Elementary Thermodynamics," plus further chapters on entropy, combustion, steam engines and steam power plants, steam flow, and heat transfer.

AUTOGRAPHIC INDICATORS FOR INTERNAL COMBUSTION ENGINES. By J. Okill. Edward Arnold & Co., London, 1938. Cloth, 5 × 8 in., 88 pp., illus., diagrams, charts, tables, $1.80 (obtainable from Longmans, Green & Co., New York). Only indicators of the combined piston, spring, and pencil-lever type are considered, thus limiting the discussion to moderate-speed large cylinder engines with crankshaft speeds under 500 rpm. History, development, descriptions of actual instruments, diagrams, calculations, disturbing factors, and errors are included in the discussion.

CHEMISTRY AND TECHNOLOGY OF RUBBER LATEX. By C. F. Flint. D. Van Nostrand Co., New York, 1938. Cloth, 6 × 9 in., 715 pp., illus., diagrams, charts, tables, $14. Based on the translation of a French book on latex, but considerably enlarged, this book covers the various phases of rubber latex in industry. The gathering, composition, properties, and handling for shipping of latex are discussed; the numerous applications in manufacturing fields are considered in detail; and information is given concerning artificial dispersions of rubber.

DESIGN OF MACHINE MEMBERS. By A. Vallance. McGraw-Hill Book Co., New York and London, 1938. Cloth, 6 × 9 in., 514 pp., illus., diagrams, charts, tables, $4. This textbook, the first of a series devoted to production development, is intended for students with some training in kinematics, mechanics, and factory processes. With this basis, the work explains the theory involved in the design of the elements of operating machines and points out the variations from theory required by practical operations.

ELEMENTARY PRACTICAL MECHANICS. By J. M. Jameson and C. W. Banks. Fourth edition. John Wiley & Sons, New York, 1938. Cloth, 6 × 9 in., 363 pp., illus., diagrams, charts, tables, $2.75. In revising this work, the editor has made a number of changes designed to make the arrangement more convenient and to bring the text up to date. A new chapter on heat has been added and the chapters on motion and on work and energy have been expanded. Numerous additions and many new problems are included throughout. The book is designed primarily for elementary technical and manual-training schools, and as an introductory course in engineering colleges.

ELEMENTARY PRACTICAL PHYSICS. By N. H. Black and H. N. Davis. Macmillan Co., New York, 1938. Cloth, 5 × 9 in., 710 pp., illus., diagrams, charts, tables, $2. A textbook for high-school students by two authorities in the field of physics. The subject is presented thoroughly, in simple language, and the significance of each principle is illustrated by applying it to familiar applications. Numerous diagrams and examples are included, and a large supply of problems and questions.

ELEMENTARY THERMODYNAMICS. By V. M. Faires. Macmillan Co., New York, 1938. Leather, 6 × 9 in., 225 pp., illus., diagrams, charts, tables, $2.60. A presentation of the topics of importance for short courses in thermodynamics. These topics include energy equations, reversible nonflow gas processes, thermodynamic cycles, compression and expansion of air, liquids, vapors and vapor cycles, refrigeration, nozzle flow, and the properties of mixtures. Many problems are appended.

ELEMENTS OF MECHANISM. By P. Schwamb, A. L. Merrill, and W. H. James. Fifth edition. John Wiley & Sons, New York, 1938. Cloth, 6 × 9 in., 400 pp., diagrams, charts, tables, $3.50. Intended to give familiarity with the application of the fundamental principles of kinematics in the field of mechanical movements, this book treats of vectors, velocity analysis, motion transmission by various means, and the characteristics of gears, wheel trains, cams, wedges, belts, and other such transmitters of power.

ESSAYS IN SCIENCE AND ENGINEERING, compiled by F. Montgomery and L. N. Becklund. Revised edition. Farrar & Rinehart, New York, 1938. Cloth, 6 × 9 in., 523 pp., charts, tables, $2. A collection of essays and articles on scientific and technical subjects designed to provide reading material for engineering English courses. The first part comprises a selection of more general essays, while the second and larger part consists of "expository models" for various kinds of technical composition.

EVOLUTION OF RAILWAYS. By C. E. Lee. *Railway Gazette*, London, 1937. Cloth, 6 × 9 in., 64 pp., illus., diagrams, 2s 6d. A history of permanent way from its earliest evidences in antiquity to the late nineteenth century, with particular reference to its development for the British mining and metallurgical industries.

GAS ANALYSIS. By A. McCulloch. H. F. & G. Witherby, Ltd., London, 1938. Leather, 6 × 9 in., 166 pp., illus., diagrams, charts, tables, 7s 6d. The construction and manipulation of five well-known types of gas-analysis apparatus are described in this book for students taking laboratory courses in fuel technology. Calorific value and other miscellaneous determinations, absorbents, and sampling of gases are also discussed.

HANDBOOK OF AERONAUTICS, Vol. 1. By Royal Aeronautical Society. Third edition, enlarged. Sir Isaac Pitman & Sons, London; Pitman Publishing Corporation, New York, 1938. Cloth, 6 × 9 in., 639 pp., illus., diagrams, charts, tables, $10. This handbook, which is issued under the authority of the Royal Aeronautical Society, has an established place as an authoritative collection of data needed by designers and builders of aircraft. In the new edition, of which this is the first of three volumes, the material has been brought

up to date by specialists. Aerodynamics, airplane performance, construction, materials, instruments, air surveying and photography, meteorology, and the design and construction of gliders and sailplanes are covered in volume one.

ILLUSTRIERTE TECHNISCHE WÖRTERBÜCHER, Deutsch - Englisch - Französisch - Italienisch - Spanisch-Russisch. Bd. 1: Maschinenelemente, Machine Elements, Éléments des Machines, Elementi di Macchine, Organos de Máquinas, Detali Mashin. Edited by W. Eppner. Third edition, revised and enlarged. V.D.I. Verlag, Berlin, 1937. Cloth, 7 × 10 in., 438 pp., diagrams, 36 rm. (27 rm. in U. S. A.) This dictionary provides definitions of words and phrases relating to the elements of machines. About five thousand terms are included, with the synonyms in English, French, German, Spanish, Italian, and Russian. Illustrations are used to clarify meanings. This edition has been entirely rewritten, is greatly enlarged, and is improved in format. It is an invaluable addition to the series in which it is included.

JACOB MAYER, Der Erfinder des Stahlformgusses. Zur 125. Wiederkehr seines Geburtstages am 1. Mai 1938. (Schriftenreihe der Arbeitsgemeinschaft für Technikgeschichte des Vereines deutscher Ingenieure.) By W. Bertram. V.D.I. Verlag, Berlin, 1938. Paper, 6 × 8 in., 71 pp., illus., diagrams, charts, 2.50 rm. A brief history of the life and work of Jacob Mayer, called the originator of steel casting, and of the beginnings and development of the steelworks at Bochum, which owed their existence to his untiring application.

JIGS AND FIXTURES. By F. H. Colvin and L. L. Haas. Third edition. McGraw-Hill Book Co., New York and London, 1938. Cloth, 6 × 9 in., 354 pp., illus., diagrams, charts, tables, $3.50. A complete, practical manual dealing with the fundamentals of jig and fixture design. Includes new material on economies of design and standard practices from large concerns which is of importance in figuring costs. There are also new details of various features to assist the designer in producing efficient and economical work-holding devices.

MACHINE GUNS. By G. S. Hutchison. Macmillan & Co., New York and London, 1938. Cloth, 6 × 9 in., 349 pp., illus., maps, $7. The development and tactical employment of the repeating weapon is traced from antiquity to modern times, with special emphasis on three major operations: The Franco-German War, the Russo-Japanese War, and the Great War. A history of the British Machine Gun Corps, 1915–1922, is included with the more general context.

MESSEN UND PRÜFEN VON GEWINDEN. (Werkstattbücher für Betriebsbeamte, Konstrukteure und Facharbeiter, edited by H. Haake. Heft 65.) By K. Kress. Julius Springer, Berlin, 1938. Paper, 6 × 9 in., 63 pp., illus., diagrams, charts, tables, 2 rm. A discussion of the measurement and testing of screw threads, both inside and outside. Thread tolerances as a basis of interchangeability are considered. There is also information concerning manufacturing accuracy and the measurement and testing of screw-cutting tools.

MITTEILUNGEN AUS DEN FORSCHUNGSANSTALTEN GHH-Konzern. Bd. 6, Heft 3, April, 1938, pp. 65–96, inclusive. V.D.I. Verlag, Berlin, 1938. Paper, 8 × 12 in., illus., diagrams, charts, tables, 3.60 rm. Contents: Scavenging in supercharged engines, by A. Schuette; recent knowledge concerning the shape strength of cast-iron structural members, by E. Mickel; elementary presentation of the theory of coaxial wide-channel cables, by H. W. Droste.

PRINCIPLES AND PRACTICE OF LUBRICATION. By A. W. Nash and A. R. Bowen. Second edition, revised. Chemical Publishing Co., New York, 1937. Cloth, 6 × 9 in., 345 pp., illus., diagrams, charts, tables, $7.25. A presentation of the salient features of the subject of friction and lubrication, covering the chemistry, characteristics, testing and care of lubricants, friction fundamentals and testing machines, and the design and lubrication of bearings. Useful tables and charts are appended.

PRINCIPLES OF ENGINEERING ECONOMY. By E. L. Grant. Revised edition. Ronald Press Co., New York, 1938. Cloth, 6 × 8 in., 431 pp., diagrams, charts, tables, $3.75. Demonstration of a practical technique providing an engineering basis for making economic decisions is the purpose of this book. Interest, valuation, and rate of return calculations are explained. The making of estimates for new enterprises, replacement problems, and the planning of future developments are discussed. Appendixes contain notes on cost estimating, interest tables, and a list of selected references.

PROBLEMS ON APPLIED THERMODYNAMICS. By V. M. Faires and A. V. Brewer. Macmillan Co., New York, 1938. Paper, 6 × 9 in., 137 pp., charts, tables, $1.40. Contains 1403 problems designed especially for use with Faires's "Applied Thermodynamics," but usable with other textbooks as well. Tables of the properties of fluids and charts depicting those properties are included in the volume.

RÔLE OF SCIENTIFIC SOCIETIES IN THE SEVENTEENTH CENTURY. By M. Ornstein. University of Chicago Press, Chicago, 1938. Cardboard, 6 × 9 in., 308 pp., illus., tables, $3. An interesting and valuable contribution to the history of science, which calls attention especially to the ways in which scientific development was aided by the scientific societies of the seventeenth century. It also contains valuable accounts of the work of many famous scientists of the period and a description of the scientific work of the universities. There is a bibliography. The new edition retains the text of the original one, but also contains numerous illustrations.

STEELS FOR THE USER. By R. T. Rolfe. Chemical Publishing Co., New York, 1938. Cloth, 6 × 9 in., 280 pp., illus., diagrams, charts, tables, $8.50. Carbon steels, with particular reference to bright and free-cutting steels, are the subject of this expansion of material which appeared in a series of articles in *Iron and Steel Industry*. Composition, heat-treatment, case hardening, mechanical testing, and the selection of steels are discussed, with a special chapter on the use of steels at elevated temperatures.

STRENGTH OF MATERIALS. By N. C. Riggs and M. M. Frocht. Ronald Press Co., New York, 1938. Cloth, 6 × 9 in., 432 pp., illus., diagrams, charts, tables, $3.75. This book is intended for use in a first course in the subject and is designed for students with a knowledge of the calculus and the fundamentals of statics. Unusual features are a brief treatment of the theory and application of photoelasticity to the study of stresses, and the inclusion of curves giving the factors of stress concentration. The authors have endeavored to produce a unified, teachable text which stresses fundamental principles and illustrates the applications of the theory by numerous practical problems.

SYMPOSIUM ON PLASTICS. Rochester Regional Meeting, March 9, 1938, Phila., Pa., American Society for Testing Materials. Paper, 6 × 9 in., 51 pp., illus., diagrams, charts, tables, $0.75; to members, $0.50. Six papers by authorities in the plastics field are contained in this pamphlet with some discussion material. Topics covered include the properties of an ideal plastic, various testing procedures, and discussions of hardness and permanence of plastics.

TECHNOLOGIE DES ALUMINIUMS UND SEINER LEICHTLEGIERUNGEN. By A. von Zeerleder. Third edition. Akademische Verlagsgesellschaft, Leipzig, 1938. Cloth, paper, 6 × 10 in., 449 pp., illus., diagrams, charts, tables. Cloth, 20 rm; paper, 18 rm. This treatise affords the most complete account of the technology of aluminum and its alloys that has yet appeared. After brief introductory chapters on the manufacture of aluminum and the theory of alloys, the properties of the commercial alloys are presented in extensive tables. Succeeding chapters discuss properties and methods of investigation, furnaces and heat-treatment, casting, rolling, stamping and drawing, forging, welding and soldering, riveting, cutting, powdering, surface treatment, uses, and standards. There is a good bibliography. This edition has been thoroughly revised and enlarged.

TENDANCES ACTUELLES DES TECHNIQUES DE LA CHALEUR. By M. Véron. Dunod, Paris, 1938. Paper and bound, 6 × 8 in., 189 pp., illus., diagrams, charts, tables; paper, 48 fr.; bound, 65 fr. This volume presents a synthesis of present tendencies in heat engineering, based upon a conference held in 1936. The essential notions underlying heating apparatus are reviewed, after which the author describes the practical applications of accelerated convection in boilers and heating furnaces, and discusses the practical consequences of modern work on radiation. A thorough study of present tendencies in boiler design is followed by short accounts of tendencies in furnace and grate construction.

V.D.I. (Verein deutscher Ingenieure) Sonderheft FLUGABWEHR. V.D.I. Verlag, Berlin, 1938. Paper, 8 × 12 in., 51 pp., illus., diagrams, charts, tables, 2.75 rm. This pamphlet contains nine papers upon various aspects of antiaircraft defense, reprinted from the *Zeitschrift des Vereines deutscher Ingenieure* and the *Rundschau technischer Arbeit*. Collectively, they afford a general review of current developments, with emphasis upon the engineering problems involved in the construction and use of defense equipment.

WÖHLER-INSTITUT MITTEILUNGEN, Heft 33. Die Steigerung der Dauerhaltbarkeit von Schrauben durch Gewindedrücken, by E. Wedemeyer. Oberflächendrücken und Druckeigenspannungen, by O. Föppl. Friedr. Vieweg & Sohn, Braunschweig, 1938. Paper, 6 × 8 in., 65 pp., illus., diagrams, charts, tables, 4 rm. The major portion of this pamphlet is devoted to an analysis of the holding power of screws as related to the thread pressure. Equipment and procedures are described for tests on screws with $^1/_2$- and $^5/_8$-in. Whitworth threads. There is included a separate paper on the relation between surface pressures and internal stresses.

A.S.M.E. NEWS

And Notes on Other Engineering Activities

Program for Joint Coal Meeting in Chicago, October 13–15

A.S.M.E. and A.I.M.E. to Hold Second Joint Meeting Western Society of Engineers and Other Interested Groups Cooperate

THE first joint meeting of the Fuels and Coal Divisions of The American Society of Mechanical Engineers and the American Institute of Mining and Metallurgical Engineers, held in Pittsburgh during October of last year, witnessed three hundred engineers from the two organizations assembled in convention. Three memorable days were spent in getting better acquainted with each other, and with the mutual problems confronting the producers and consumers of coal.

The first meeting was so successful it called for an encore, and it was decided that the next meeting be held in Chicago, the nation's leading soft-coal market. The Western Society of Engineers added its sponsorship to the forthcoming get-together, and other interested local and near-by groups agreed to cooperate.

Within the Chicago industrial area, and but a short jaunt by car, is one of the world's largest strip coal mines. The convention city is also preeminent for its central-power-supply system and for its iron and steel plants—both heavy users of coal. To coal men it is also known as the location of one of the leading makers of coal-mining machinery. Three concurrent inspection trips have been planned with these points in mind, for members and guests. The meeting is to be predominantly for men. Headquarters will be at the Palmer House Hotel. The program is as follows:

THURSDAY, OCTOBER 13

9:00 a.m.

Registration, Inspection-Trip Arrangements, etc., Palmer House.

10:00 a.m.

Joint Morning Session

Technical Session

Chairman, W. S. Monroe
Vice-Chairman, John A. Garcia
The Bureau of Mines Experimental Coal Hydrogenation Plant, by A. C. Fieldner and H. H. Storch, U. S. Bureau of Mines, Washington, D. C.
Influence of Mechanization on Location of Coal Production in Illinois, by Paul Weir, consulting engineer, Chicago, Ill.

12:30 p.m.

Buffet Luncheon ($1.25) Rooms Adjacent to Meeting.

2:00 p.m.

Joint Afternoon Session

Technical Session

Chairman, Alex Bailey
Vice-Chairman, Carl Hayden
Fundamentals of Combustion in Small Underfeed Stokers, by C. A. Barnes, Battelle Memorial Institute, Columbus, Ohio
Iowa Coal as a Domestic Stoker Fuel, by M. P. Cleghorn, Iowa State College, Ames, Iowa
Factory Testing of Propeller Mine Fans, by Raymond Mancha, Jeffrey Manufacturing Co., Columbus, Ohio

6:30 p.m.

Buffet Dinner ($1.50) Red Lacquer Room, Palmer House
An exhibition of the new technicolor sound film "Steel—Man's Servant"

FRIDAY, OCTOBER 14

9:30 a.m.

Joint Morning Session

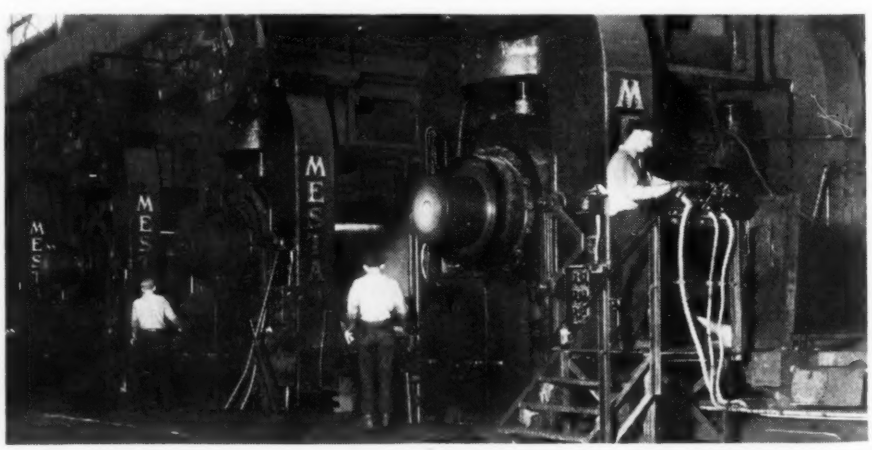
Technical Session

Chairman, Tom Marsh
Vice-Chairman, R. H. Morris
Use of Low-Grade Coals in Modern Steam-Generating Equipment, by Ollison Craig, Riley Stoker Corp., Worcester, Mass.
Panel Discussion on Coal Purchasing
Viewpoint of Preparation of Coal, J. B. Morrow, Pittsburgh Coal Co.
Viewpoint of Purchasing Agent, T. W. Harris, Jr., E. I. du Pont de Nemours & Co.
Viewpoint of Coal Sales, B. Gebhardt, Chicago, Wilmington, and Franklin Coal Company
Viewpoint of Purchasing for a Municipality, T. Jeffords, City of Detroit
Viewpoint of Consumer, A. W. Thorson, The Detroit Edison Company
The Effect of Preparation on Ash Fusibility of Certain Illinois Coals, by L. C. McCabe and O. W. Rees, Illinois State Geological Survey, Urbana, Ill.

2:00 p.m.

Technical Session

Chairman, Newell G. Alford
Vice-Chairman, C. A. Gibbons
Mechanical Mining at Consolidated Coal Company, by G. Stuart Jenkins, Consolidated Coal Co., St. Louis, Mo.
Material Handling in Coal Preparation Plants, by Nelson L. Davis, Link-Belt Company, Chicago, Ill.
Haulage in Strip Coal Pits, by Albert L. Toenges, U. S. Bureau of Mines, Pittsburgh, Pa.



INLAND STRIP MILL TO WHICH VISIT IS PLANNED DURING CHICAGO COAL MEETING

2:00 p.m.

Afternoon Concurrent Session, A.I.M.E.

Technical Session

Chairman, Gordon MacVean
Vice-Chairman, J. E. Jones

The Safety Practices of the Koppers Coal Company, by L. C. Campbell, Koppers Coal Company, Pittsburgh, Pa., Recent Trends in Rock Dust Practice, by H. P. Greenwald, U. S. Bureau of Mines, Pittsburgh, Pa. Organized Safety in the Anthracite Field, by Clyde G. Brehm, Susquehanna Colleries Co., Nanticoke, Pa.

2:00 p.m.

Afternoon Concurrent Session, W.S.E. and A.S.M.E.

Technical Session

Chairman, Loran D. Gayton
Vice-Chairman, R. E. Turner

Use of Metals for High-Pressure High-Temperature Steam Generators, by B. W. Whitmer, Republic Steel Corp., Massillon, Ohio

Coal for Metallurgical Furnace Firing, by W. R. Bean, Whiting Corporation, Harvey, Ill.

Ash Handling, by J. J. Peterson, Chicago Tunnel System, Chicago, Ill.

4:30 p.m.

An informal visit to the Chicago Tunnel System (which can be entered by elevator from the headquarters hotel) lasting about an hour, is planned at the close of this session.

6:30 p.m.

Dinner (Banquet), Red Lacquer Room, Palmer House ($2.00)

Toastmaster, W. L. Abbott, Chicago, Ill., President, The American Society of Mechanical Engineers, 1926, and Western Society of Engineers, 1907.

Speaker, Howard Eavenson, Pittsburgh, Pa., President American Institute of Mining and Metallurgical Engineers, 1934.

SATURDAY, OCTOBER 15

Inspection Trips. Registration for any one of the three trips will be made when securing meeting registration badges Thursday morning, so transportation may be arranged. Plants are hosts at lunch, in each case.

Northern Illinois Coal Corporation, Wilmington, Ill. One of the large strip coal mines, with 5000 tons daily capacity. A feature is the 32-cu-yd strip shovel, one of the largest, weighing 3,200,000 lb and with operating range, shoveling to dumping, of 200 ft. Preparation plant handles coal $3^1/_2$ in. and down, and has complete washing, classifying, dewatering and drying equipment.

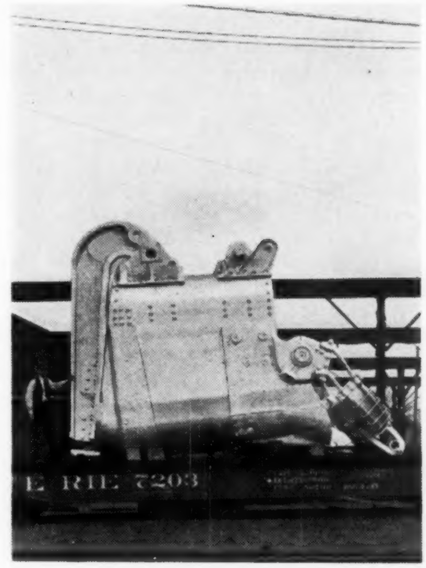
Inland Steel Company, Indiana Harbor, Ind. In 1937, this plant installed a new blast furnace, first to be built in U. S. in about six years. Other late improvements include four new 125-ton open hearths, and continuous bar, strip, and sheet-rolling mills. Modern coal handling, coke ovens, power plant, and general steel-plant practice exemplified.

Goodman Manufacturing Co., and Fisk Station, Chicago, Ill. Goodman, well-known pioneer makers of mining machinery, will have some machines on assembly floor for demonstration, or under test. Lunch at Goodman's, followed by visit to Fisk Station, pioneer steam-turbine station in U. S., and for 25 years, world's largest. Portrays evolution of these plants and presents modern 30,000-kw turbine operating at 1200 lb pressure and 900 F.

Officers and Committees

Officers and committees handling this joint meeting are for the Fuels Division, A.S.M.E., M. D. Engle, chairman, A. R. Mumford, secretary, H. F. Hebley, chairman, Joint Committee; for the Coal Division, A.I.M.E., Paul Wier, chairman, C. A. Gibbons, vice-chairman, David R. Mitchell, secretary; for the Mechanical Engineering Section, W.S.E., J. S. Y. Fralich, chairman, F. L. Spangler, vice-chairman, J. M. Lee, Program Committee.

The Joint Committee has H. F. Hebley, as chairman, with G. B. Gould, J. E. Tobey, D. R. Mitchell, Ralph A. Sherman, and B. J. Cross as members.



32-cu-yd dipper for strip shovel

Four Days of Technical Sessions Planned for A.S.M.E. Annual Meeting, December 5–9

Other Features Include Photographic Exhibit, Junior Members' Dinner, and National Exposition of Power

PRELIMINARY plans for the Fifty-Ninth Annual Meeting of The American Society of Mechanical Engineers in New York City, Dec. 5–9, 1938, indicate a program which should appeal to mechanical engineers, near and far, because of its diversity and inclusiveness. Whether he be president, chief engineer, or junior engineer of a public utility, textile plant, machine shop, or automotive factory, the A.S.M.E. member will find the technical session in his particular field so replete with information, interest, and discussion, that he should be repaid manifold for his time and expense in attending. The following summary of the topics to be covered at the various sessions gives a general idea of the program.

STEAM POWER

It was only a relatively few years ago that the first high-pressure, high-temperature steam boiler and turbine were installed. Since then, though many plants have been so equipped, engineers are still encountering many problems in the operation of the new units, according to papers to be presented about the installations in Detroit. Operation of the furnaces to be used with the new boilers will be discussed by E. G. Bailey, Babcock & Wilcox Co. The story of the application of the new method to a turboelectric ship should be interesting.

The effect of high-pressure, high-temperature steam on flow measurement will be covered by two papers. A committee will report on the effect of high-temperature steam upon alloys. Joseph H. Keenan, member of the Society, who compiled the well-known "Steam Tables and Mollier Diagram," will present a paper on "Friction Coefficients for the Compressible Flow of Steam." At the same session, reheat factors for superheated- and wet-steam expansion will be discussed by Chas. G. Thatcher, and the calculation of the reheat factors for steam turbines will be described by Ronald B. Smith.

MANAGEMENT

Whether it is done by the government or by private industry, there are certain direct and indirect expenses involved in apprentice and industrial training. Papers on the subject by two well-known industrial executives are scheduled. Job evaluation and industrial organization are two other topics to be covered at sessions under the sponsorship of the Management Division.

Last year, the management dinner and the factory-maintenance luncheon were "sell-outs." This year, a job-shop-management luncheon is also planned besides the other two affairs.

Many power and industrial plants present a problem in the control of coal and other dust because of the danger of explosion. A method of controlling the hazard, developed by the U. S. Department of Agriculture, will be described by one of its engineers. Another speaker will discuss the relation of safety to plant layout.

AERONAUTICS

It is expected that Prof. Heinrich Focke, inventor of the helicopter bearing his name, will come to New York from Germany and describe the development of his machine which has, according to him, solved the problem of the take-off and landing of aircraft in a small space. The American side of the story will be presented by the chief engineer of the company which has developed the Pitcairn autogiro. A new method of rolling sheets suitable for airplane construction purposes will be discussed by Alexander Klemin. Particularly interesting should be the progress report of the Aeronautic Division in which the latest developments in the construction of super-air liners will be included.

MACHINE-SHOP PRACTICE

Claiming much attention today is the development of hydraulically operated tools and machines. Engineers attending this session should learn a lot from the papers to be presented on the theory of hydraulic units and their application to machine tools.

Another session will see the presentation of a report by a research committee on the effects of size and shape of cut upon the performance of cutting fluids. The use of the electric pressure gage in the machine shop is another topic of interest to be discussed at one of the sessions.

APPLIED MECHANICS

Engineers who are in any way concerned with spring problems in their design work will welcome the presentation of the results of tests on the stresses and deflection of helical springs. Another subject of importance to designers of power plants will be covered by papers on pipe-stress problems and their solutions.

In cooperation with the Ordnance Department, U. S. Army, the Applied Mechanics Division is sponsoring a session on strength of materials where papers on special problems in material testing, interpretation of failures in ordnance, and the use of piezoelectric gages in measuring powder pressures, will be given.

Iron and steel engineers will have an opportunity to listen to talks on the subjects of steel rolling, the effect of speed of stretching and loading on the yielding of mild steel, and hard surfacing processes and materials.

FUELS

Fuel-bed conditions will be discussed by engineers from the Carnegie Institute of Technology, Battelle Memorial Institute, and the Consolidated Edison Company. A method of utilizing pulverized-coal ash is the subject of a paper which should appeal to many power-plant engineers.

HEAT TRANSFER

Because many modern turbines are being cooled with hydrogen, the two papers on this subject should attract many who wish to know more about it. There is a possibility that Erich Lieb will present a paper on the thermodynamic properties of vapors.

GRAPHIC ARTS

For several years the A.S.M.E. has been directing attention to the engineering phases of the printing and graphic-arts industries. As a part of this years' program T. E. Dalton, secretary of the Graphic Arts Division, will present a paper on engineering and its relation to the graphic arts. At the same session, another paper will describe "roll curve" gears that have been developed to accomplish some of the peculiar motions required on printing presses.

HYDRAULICS

Two sessions are scheduled by the Hydraulic Division at which papers on the errors of pitot tubes, pitometer research, and load swings on hydroelectric plants will be presented.

OIL AND GAS POWER

Many members, who are interested in oil and gas power, will learn something from the paper which describes a new instrument developed at the Brooklyn Navy Yard for the solution of internal-combustion-engine design problems. Another paper will bring out the latest developments in oil and gas engines.

RAILROADS

From an examination of the papers submitted, it seems that the designers of steam locomotives have not been entirely idle during the development of Diesel equipment. One paper describes the cross-balancing steam locomotive. The electric locomotive comes in for its share of attention too.

Many railroad mechanical engineers, who attended last year's sessions, will recall the excellent paper by Rupen Eksergian. This year he intends to discuss motive-power characteristics and lightweight equipment.

INSTRUMENTS

The Process Industries Division is arranging a session on industrial instruments at which automatic combustion and the regulation of industrial processes are two of the topics to be discussed. An integrating traverse pressure recorder will also be described. Interesting to many designers and plant engineers should be the paper on photoelectric cells and their application to process control.

FLUID METERS

There will be presented for discussion at a symposium a paper on the coefficients of orifices and nozzles with free and also submerged discharge. Pulsating flow and its effect on measurement will be another topic for discussion. Research work carried out on flow nozzles with oil will be reviewed.

TEXTILES

Textile people have a language of their own. For instance, take the word roving. It means wandering to most of us but to textile engineers it describes an operation done by a frame or machine. At a session to which engineers from other fields, even though they don't understand textile language, are welcome, papers will be presented on high-speed long-draft combed roving as well as on long superdraft roving.

LUBRICATION RESEARCH

With high-speed, high-pressure machinery of all descriptions coming more into daily use, lubrication becomes a subject of increased importance. From the laboratories of schools and industrial plants, research engineers are coming to present the results of their studies on oil films, temperature distribution in bearings, and wear-testing of metals.

COMPLETE PROGRAM

The foregoing is only a brief preview of what is being planned in the way of technical sessions for the Fifty-Ninth Annual Meeting in New York, Dec. 5–9. It is suggested that you jot those dates on your calendar right now as something which you shouldn't miss. A complete program of events will be published in next month's MECHANICAL ENGINEERING.

A.S.M.E. Calendar

of Coming Meetings

October 5–7, 1938
Fall Meeting
Providence, R. I.

October 13–15, 1938
Fuels Division Meeting (jointly with A.I.M.E. Coal Division)
Chicago, Ill.

October 18, 1938
Joint Meeting with American Welding Society
Detroit, Mich.

December 5–9, 1938
Annual Meeting
New York, N. Y.

February 23–25, 1939
Spring Meeting
New Orleans, La.

Power Exposition in New York During Week of December 5

DURING the time of the Annual Meeting of the A.S.M.E. in New York, Dec. 5–9, the Thirteenth National Exposition of Power and Mechanical Engineering will be going on at Grand Central Palace. Since its inception in 1922, the Power Show has become the traditional means by which manufacturers in the power and allied fields display their latest products.

If expositions of the past year in other fields indicate a trend at all, a munificence of operating demonstrations and dynamic, colorful displays will feature this year's presentation of power.

An attendance of 40,000, including many A.S.M.E. members in New York for their meeting, is indicated.

Preprints of A.S.M.E. Transactions Papers to Be Provided

Council Acts to Establish Partial Preprint Service

As a result of several meetings during the summer of the Advisory Board on Technology, and the Committees on Professional Divisions, Meetings and Program, and Publications, the Executive Committee of the Council of The American Society of Mechanical Engineers has voted to make an important change in publications procedure that will provide (1) a limited preprint service, and (2) the printing in the Transactions of papers, simultaneously with discussion on them, after they have been presented at meetings. The change will go into effect at once, although several months will be required to complete the transition.

It will not be possible to provide a complete preprint service at the present time, but the action decided upon is a first step in that direction. Under the plan adopted all papers for Society meetings, received in time and approved for publication in the Transactions, will be preprinted. By writing to headquarters, members will be able to secure copies of preprints before meetings as long as the supply lasts. Notice of the availability of these preprints will be given through Mechanical Engineering and advance editions of the meeting program. Copies of preprints will also be distributed to those attending the sessions at which the papers are presented. After the meeting, the papers will be published, with discussion and closure, in the Transactions.

Policies Adopted Looking Toward Better Papers and Meetings

At the present time the appropriation of the Committee on Publications for the Transactions will permit the printing in any twelve-month period of approximately 100 papers, and hence not more than 100 preprinted papers can be promised during the fiscal year. However, as experience with the plan grows, and if policies adopted by the Board on Technology become effective, this number may be increased. The policies referred to were adopted by the Advisory Board on Technology at a meeting on July 27, and have the general approval of the Committees on Professional Divisions, Meetings and Program, and Publications. They may be briefly summarized as follows:

1 An attempt is to be made to reduce the total number of technical papers available for publication by setting limits to the number of sessions at Annual, Semi-Annual, Spring, and Fall meetings of the Society and to limit the number of papers at any session to two.

2 Papers are to be limited to 4000 words, in so far as it is practicable to do so.

3 Greater care is to be exercised in the reviewing and recommending of papers for publication by the establishment in each professional division of an editorial committee.

4 Greater efforts are to be expended in securing manuscripts well in advance of meetings.

5 A change in program-making policy is recommended which will have the effect of basing programs on good material actually in hand rather than on papers which, the sponsors hope, may be secured and may be worthy of publication.

Emphasis is placed on the policies announced by the Advisory Board on Technology. It is important for the success of the new plan that members should understand these policies and cooperate in making them effective. They aim at increasing the quality of papers and meetings, at giving the additional preprint service, at providing more papers without increasing publication costs by insisting that every writer be as brief as possible, and at securing manuscripts well in advance of meetings so that they can be properly reviewed and approved, and, if possible, preprinted.

Reasons for Adopting Partial Preprint Service

It is well known that the four national meetings of the Society and the national meetings of the divisions produce many more than 100 papers for the year. Because it is impossible to preprint every one of these papers, the new plan is called a partial preprint service. A complete service would also provide copies of papers published in Mechanical Engineering, and copies of papers not published in either Transactions or Mechanical Engineering.

In spite of the fact that the new service is not complete, it will be found to be much more satisfactory than no preprint service at all, as at present. Moreover, the present policy of publishing papers approved for Mechanical Engineering in that Journal in advance of presentation will be maintained, so that every member will have an opportunity to read these papers before he comes to the meeting. Reprints of these Mechanical Engineering papers for distribution at meetings are desirable, but because of the cost they will not be provided under the new plan. Members will have to rely upon Mechanical Engineering, as in the past, for the text of these papers.

Papers received after the "dead line" cannot be printed in any event, regardless of cost.

Papers That Are Not Published May Be Abstracted

Every meeting program announces addresses that are not subject to discussion and that may lose in interest if distributed in preprint form in advance of presentation. These will be published, as they are now, after presentation. Every program also contains progress reports, informal extemporaneous talks, and papers of limited interest that are not recommended for publication in Transactions or Mechanical Engineering. Naturally, these cannot be preprinted, although, in many cases, mimeograph copies could be provided were it not for the cost involved. An effort will be made to report a majority of these in abstract in Mechanical Engineering.

Transactions to Continue on Monthly Basis

Every member will continue to receive 12 monthly issues of Transactions every year, four of which will be issues of the *Journal of Applied Mechanics*. For the next six months or so these issues will contain papers delivered at past meetings. For several months it will be necessary to publish the paper and the discussion in separate issues, but, beginning with papers for the Providence Meeting, Oct. 5 to 7, 1938, paper, discussion, and author's closure will appear complete in a single issue. By late spring, 1939, the transition will probably be completed as by that time all papers and discussions prior to Oct. 1, 1938, will have been published.

A.S.M.E. Graphic Arts Division Announces New Program of Activity

Thomas E. Dalton, Division Secretary, Says Plans Are to Be Developed Nationally and Locally

A new program of activity for the A.S.M.E. Graphic Arts Division was adopted by its executive committee at a meeting on May 20, 1938, which will cover six points of development to be worked out nationally and locally. These plans are as follows:

Papers at General Meetings

(1) To arrange for the presentation of technical engineering papers at the Annual and other general meetings of the Society.

In recent years the Division has not presented technical papers at these general meetings and it feels that it will be wise to bring both the engineering problems and accomplishments in the printing-industry field before the membership of the Society.

Cooperation With Other Organizations

(2) To cooperate with other graphic-arts organizations where mechanical engineering can assist in the study and solution of problems facing the printing industries.

Many of the problems within these industries are not of a mechanical-engineering nature. There are others, however, that might well be studied and solutions recommended by men with engineering training as well as with practical experience.

Small-Group Discussions

(3) To organize graphic-arts forums in New York, Chicago, and other centers where interest warrants group discussions.

The purpose of such forums will be the dis-

cussion of printing problems among engineers and practical printing draftsmen who will meet in small groups more frequently and less formally than is possible at larger conventions.

It has been found from experience at annual conferences that the discussion of graphic-arts problems in typography, engraving, typesetting, electrotyping, presswork, ink, paper, binding, press building, and similar subjects cannot sustain the interest successfully of large groups. Smaller groups and more frequent discussions are essential to sustain interest and to develop solutions for the many problems facing the industry. Planned coordination is essential and it is to this that the annual conferences should devote more attention.

On this point of smaller-group discussion, it is interesting to note that in recent years the conventions of Printing House Craftsmen's Clubs have arranged clinics on various printing subjects, held simultaneously in different groups during each session of its convention.

The engineering forum program would confine itself to engineering problems of machines, processes, materials, and standards. A better understanding between the engineer and the craftsman is also required in the solution of these problems. These discussions with the engineer and the craftsman working together would bring about the coordination so badly needed in this complex industry in which there are so many intangible and disturbing factors.

Adoption of Standards

(4) To encourage the adoption of standards for testing raw materials, measuring production, etc., required by the graphic-arts industries.

This point of activity is long-range in its outlook and will call for a careful and slow beginning. In the past many standards have been set up, too hastily prepared, later to prove ineffectual.

The printing industry is highly specialized and is widely diversified in its services to the buyer and consumer of printing material. This condition emphasizes the need for standardization where it can be adopted and maintained. Standards must be adopted cautiously and not until exhaustive study makes it possible to obtain a majority of acceptance upon a practical basis.

Management in the Printing Field

(5) To encourage the use of engineering principles and practices in management.

The existence of a Management Division in the Society might make this point of activity for the Graphic Arts Division seem somewhat unnecessary, but it is thought that the peculiar and highly specialized requirements of the printing industries call for separate study and a place for management in the Division's program of activity. The Graphic Arts Division will work in close cooperation with the established Management Division of the Society on all problems of management presented by the printing industries.

Graphic Arts in Engineering Curricula

(6) To assist in engineering education wherever the graphic arts are related to the engineering curricula of a school or college.

This is a fundamental aim of the A.S.M.E. and therefore should have a place in the program of all divisions. It has occurred to members of the Division that experimental work in the laboratory or shops of a school such as the Carnegie Institute of Technology, whose school of printing is outstanding, would bring the practical problems of the industry to the very classrooms of the college, itself.

The adoption of this program of activity will carry out the general objects of the A.S.M.E. within the graphic-arts field of industry.

A.S.M.E. Mid-Continent Office Moved

AFTER being located for several years in the Tulsa Building, Room 102, the Mid-Continent Office of The American Society of Mechanical Engineers in Tulsa, Okla., was moved in the early part of September to the Midco Building, Room 211.

Third Annual A.S.M.E. Photographic Exhibit to Be Held During 1938 Annual Meeting

Technical and Nontechnical Prints May Be Submitted by Members on or Before Nov. 25

PHOTOGRAPHY will come in for its share of attention at the fifty-ninth Annual Meeting of the A.S.M.E. in New York, Dec. 5–9, with the holding of a photographic exhibit under the sponsorship of the Photographic Group of the Society. As in previous years, both technical and nontechnical subjects will be acceptable.

An added incentive for exhibitors will be the fact that the best photographs, as selected by members of the editorial staff of the Society, will be reproduced in MECHANICAL ENGINEERING with full credit to the photographers.

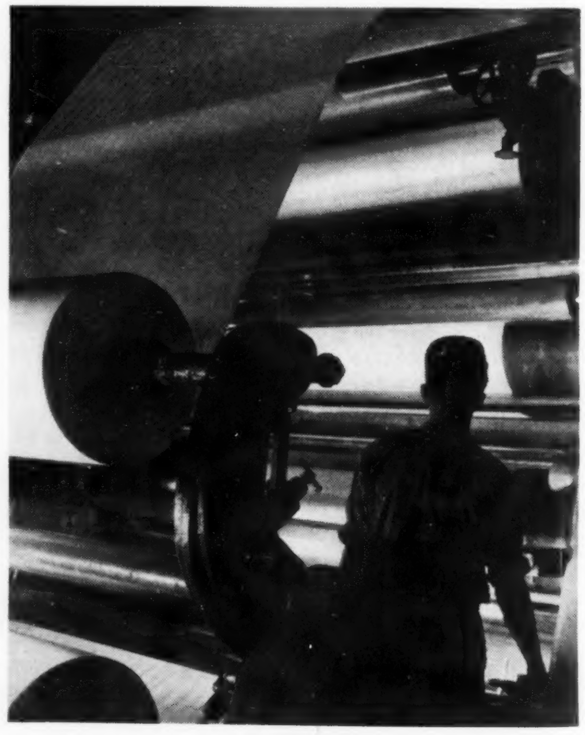
Any member of the A.S.M.E. may submit one or more photographs, but the Photographic Group reserves the right to limit the number of prints actually hung for each member to one, depending on the space available. All pictures sent in shoud be mounted on 16 × 120-in. light-colored cards.

It is also suggested that each photograph be submitted with the following data attached: Title, where taken, name of photographer, his address, camera, lens *f*, shutter, exposure, light conditions, type of film or plate, developer, and printing-paper information, if available. On the back of each print should be written the name and address of the member submitting it. This is just a precaution against possible loss.

Prints should be sent in on or before Nov. 25 to A.S.M.E. Photographic Exhibit, 29 West 39th Street, New York, N. Y. They will be returned as soon as possible after the close of the exhibit, except where prints are retained for subsequent reproduction in MECHANICAL ENGINEERING. These will be returned by the editoral department.

To facilitate the handling of prints submitted, the prints should be protected with corrugated cardboard and securely wrapped. To save postage, the photographs should be sent parcel post, insured if desired. Postal regulations forbid the enclosure of any letter in the package but permit the attachment of it to the outside of the wrapping in a stamped envelope. Enclose remittance of fifty cents to cover return postage and insurance.

Members living in or near New York City



PHOTOGRAPH BY J. A. LUCAS, SUBMITTED FOR THE 1937 EXHIBIT

may bring in and call for photographs in person. While the Photographic Group will exercise all necessary care in the handling of your prints, liability will be limited to parcel-post insurance if returned by mail.

1939 A.S.M.E. Mechanical Catalog and Directory Out

Full Directory Reinstated in this Volume

The twenty-eighth annual A.S.M.E. Mechanical Catalog and Directory, 1939 edition, was published on October 1 by The American Society of Mechanical Engineers.

Early this year a thorough study of the Mechanical Catalog as published by the A.S.M.E. was made by a special committee of which Frank L. Bradley, member of the Committee on Publications, was chairman and W. T. Conlon and R. E. Thayer members. As a result of the work of this group the Committee on Publications voted to reestablish in the 1939 Catalog on a free-listing basis a complete directory of mechanical equipment and to change the name to "A.S.M.E. Mechanical Catalog and Directory." This action was approved by the Council of the Society.

The 1939 volume contains a Catalog Section in which manufacturers describe and illustrate their products of interest to the mechanical field. This section is followed by the Directory in the unabridged form that was a feature of issues prior to 1931. The Directory is a broad and comprehensive index to the market which supplies equipment and materials in the mechanical field.

A new feature of the 1939 volume is a tradename index which has been added because it has been shown that in some instances the trade name is the only clue available for establishing the identity of a product.

A twelve-page listing of A.S.M.E. Publications is also included in this volume for the convenience of members of the Society.

Petroleum Fluid Metering Proceedings Available

All papers, together with their discussions, presented at the Petroleum Fluid Metering Conference in Norman, Oklahoma, Apr. 7–8, 1938, under the joint sponsorship of the Petroleum Division of the A.S.M.E. and the College of Engineering, University of Oklahoma, are now available in a 78-page booklet, which contains illustrations, charts, and diagrams. The price of the booklet is $1.50 and may be obtained from W. H. Carson, University of Oklahoma, Norman, Okla.

Professional Engineers Meet in Pittsburgh, Oct. 17–19

Meeting in Pittsburgh, Oct. 17–19, the National Society of Professional Engineers will convene for the Society's fourth annual convention. Headquarters will be established at the Hotel William Penn.

A.S.M.E. Metropolitan Section Educational Committee Starts Five Review Courses for Engineers

Four Courses to Aid N. Y. Professional Engineers' License Applicants

Continuing the educational program inaugurated by the Metropolitan Section, A.S.M.E., several years ago, the Educational Committee started the 1938 fall review courses for engineers on Sept. 12 at the Engineering Societies Building in New York City. This initial course, to be given every Monday evening, consists of 18 sessions on engineering economics and practice. With Prof. G. W. Barnwell, Stevens Institute of Technology, as instructor, the course is helping N. Y. Professional Engineers' License applicants to cover economic comparisons, fixed and operating costs, accounting and cost analysis, valuation, contracts, etc.

On Tuesday evenings a twenty-session course is given on structural planning and design to license applicants by S. W. Spielvogel. On Wednesday evenings, the basic engineering sciences, hydraulics, thermodynamics, machine design, etc., are being covered in a series of 20 sessions by Charles A. Hescheles, member, A.S.M.E. Thursday evenings, the chairman of the Educational Committee, G. J. Nicastro, is presenting a course of 20 sessions on mechanical engineering in which are covered air, steam, and gas-power machinery, air conditioning, refrigeration, etc.

"Learn to Think and Speak on Your Feet" is the theme of a public-speaking course of 16 sessions being offered on Fridays by Prof. R. C. Scafe. Though it does not help engineers to review for their license examinations, it aids them in everyday life as is attested by those who have completed the course in previous years.

Dates and Places for the 1938 Group Conferences

The following are the dates and locations for the 1938 Local Sections' group conferences which precede the Annual Meeting of the A.S.M.E. at which matters of Society policy are discussed.

Group I, New Britain, Conn., Oct. 29–30
Group II, New York, N. Y., Oct. 26
Group III, Philadelphia, Pa., Oct. 29–30
Group IV, Memphis, Tenn., Oct. 23–24
Group V, Columbus, Ohio, Oct. 15–16
Group VI, Tulsa, Okla., Oct. 22–23
Group VII, Los Angeles, Calif., Oct. 22–23

In order to make the program of courses self-supporting financially, a fee of $20 is charged for each course to non-member engineers and $10 for each course to A.S.M.E. members with the exception of the public-speaking course, which is $15 to the latter. Other local sections who would like to know more about the plan are advised to write for information to G. J. Nicastro, Combustion Engineering Co., Inc., 200 Madison Avenue, New York, N. Y.

Other Local Sections News

Central Illinois

Starting off the 1938–1939 year with a new name, the Central Illinois Section (previously Peoria) held its first meeting on Sept. 15 at the Hotel Pere Marquette in Peoria. A. T. McDonald, research engineer, Caterpillar Tractor Company, talked on "Diesel-Engine Lubrication Problems."

Chicago

Chicago Section opened the season with a smoker at the Hotel Sherman on Sept. 23. Refreshments, entertainment, and a special program were provided. Last year the Section finished off a successful season, in which 37 meetings were held, with a dinner on June 10 at the Medinah Club.

Steel Meeting at Detroit Oct. 18

Detroit Section invites all members to visit on Tuesday, Oct. 18, at 2 p.m., the Hanna Furnace Division of the Great Lakes Steel Corporation on Zug Island to inspect the new 1000-ton blast furnace. In the evening at 8 p.m., a meeting of the section at the Book-Cadillac Hotel will have A. L. Foell, chief engineer, A. G. McKee & Co., Cleveland, Ohio, talk on "Modern Blast Furnaces."

Mid-Continent

The Mid-Continent Section worked up a letter questionnaire which was sent to a representative group of engineers in Tulsa requesting suggestions of the types of meetings they would be interested in during the coming year and which would meet with wide acceptance. It is expected that meetings will be held not only in Tulsa but also at Shreveport, Fayetteville, and Bartlesville. The schools in the vicinity have been asked to furnish dates of Friday meetings of student branches so that members of the Section may attend these

meetings and go to the football games at the schools the next day.

South Texas

Sixty-three members and visitors were present on July 25, in Houston, Texas, to listen to H. E. Degler, member, A.S.M.E., give an address on "Recent Development and Trends in Air Conditioning." According to our records, this was the only section to hold a summer meeting. Probably the subject matter kept the boys cool.

Worcester

Meeting on Sept. 13 at Worcester Poly, members heard Dr. William A. Bryan, superintendent of Worcester State Hospital, discuss "Human Engineering and Psychology as Applied to Industry." He said, "In recent years psychologists and psychiatrists have been carrying out investigations on the loss of (industrial) personnel efficiency due to minor forms of mental disorder and to personality maladjustment. This work is still in its early stages and there are many problems to be solved in devising adequate research techniques. Nevertheless data are already at hand which suggests that investigations carried out on the human factor in industry may be of immense significance."

Junior Group Activities

Metropolitan Doings

WHILE the rest of us were enjoying summer sports and vacations, the various committees of the Metropolitan Junior Group were hard at work getting ready for the 1938–1939 season. One of these committees was the Executive Committee, headed by W. George Hauswirth, chairman of the Junior Group. Just as the results of the hard work were becoming apparent, Hauswirth, with much regret, had to resign when he was sent out of town. Consequently, the new officers are H. B. Fernald, Jr., chairman; W. W. Lawrence vice-chairman; S. Davidson, secretary-treasurer; and A. E. Blirer, W. F. Carhart, H. G. Oliver, Jr., and S. Shoor, Executive Committee members.

The survey form prepared by a special committee, Sidney Davidson, chairman, was sent out to all Junior members during the summer. From the answers received and tabulated by Davidson and his fellow workers, the Program Committee, Richard F. Warner, Jr., chairman, has already prepared an interesting program for the coming year.

Finally, but not least, there is Arthur E. Blirer, the hard-working Publicity Committee. Through Archie's efforts, the world at large was apprised that the Junior Group movement in the Metropolitan Section was very much alive, even during the hot summer. It was indeed an empty day when the editors of MECHANICAL ENGINEERING and the Metropolitan press did not find something on their desks from Archie about the Junior Group.

San Francisco Progressing

Under the direction of E. D. Kane, the first of a series of seminars planned by the San Francisco Junior Group was held on Aug. 11. About 30 junior members were present. The discussion on power-plant engineering was led by Charles E. Steinbeck, assisted by A. W. Bruce and E. G. Gothberg. The greater part of the session, which lasted two hours, was spent in discussing a new high-pressure steam-turbine plant, three of which are being installed in the vicinity.

At the regular meeting of the Junior Group on Aug. 18 at the Engineers' Club, Dr. B. M. Woods addressed the group, his topic being "The Role of the Engineer in the Conservation of National Resources."

Juniors to Hold Dinner at Annual Meeting in N. Y.

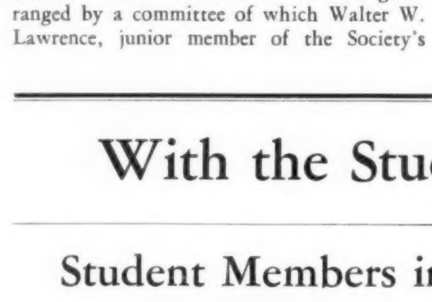
ONE OF THE most important features of the Fifty-Ninth Annual Meeting of the A.S.M.E. in New York in December will be an informal dinner on Monday evening, Dec. 5, for Junior members from all parts of the United States and Canada. It is being arranged by a committee of which Walter W. Lawrence, junior member of the Society's Committee on Meetings and Program, is chairman.

It is a little early to give complete details as to the place where it will be held or the program planned, but the committee promises to do its best in providing an appetizing dinner at a reasonable cost and to provide two interesting speakers who will have something of importance to say about the junior engineer's problems. An invitation will be extended to several distinguished engineers and executives, who are members of the Society, to attend so that they may become acquainted with the Juniors.

Since there will be several technical sessions that same evening starting at 8 o'clock or later, the dinner will begin about 6 o'clock and end in time for attendance at the sessions.

With the Student Branches

Student Members in 117 Schools Ready With Plans for Successful Year



Courtesy, D. H. Ross

STUDENT MEMBER HARD AT WORK IN "M.E. LAB," BUCKNELL

STARTING off the new school year with intensive membership drives, the 120 Student Branches of the A.S.M.E., located in 117 engineering schools in the United States and Canada, are all set to beat last year's record membership of 5229. The UNIVERSITY OF MICHIGAN STUDENT BRANCH is out to take away the honor of having the largest student branch in the A.S.M.E. from the PURDUE UNIVERSITY STUDENT BRANCH which won last year with 14 members more. It is expected that the UNIVERSITY OF CALIFORNIA STUDENT BRANCH will make it a hot, three-cornered fight.

Hundreds of meetings and inspection trips will be held during 1938–1939. Quite a few of the student branches are encouraging the presentation of papers at these meetings by the student members themselves in preparation for the Student Conferences at each of which, $95 in cash prizes will be given for the best papers presented.

Talking about the ten student conferences, do you know that they drew an attendance of 1661 last year? On the facing page, you'll find a tabulated report of each conference together with the names of the prize winners.

For the 1939 Student Conferences, according to a preliminary report which is subject to change, CORNELL BRANCH will be host to

A.S.M.E. Student Group Conferences, 1938

GROUP I—NEW ENGLAND STUDENT CONFERENCE, DURHAM, N. H., MAY 6–7

Attendance: 90 Papers presented: 10

Prize	Recipient	Title of Paper	College
First	W. F. Kaufman	Effect of Temperature on the Properties of Steel	M.I.T.
Second	S. M. Phelps	Diaphragm in Measuring Flow in a Venturi Flume	Rensselaer
Third	F. T. Allen	Testing of Wire-Rope Splices	Brown
Fourth	G. S. Bennett	Economic Limitations of the Engineer	Tufts
Fifth	G. C. Brainard	Assembly Conveyer Problems	Cornell

GROUP II—EASTERN STUDENT CONFERENCE, PHILADELPHIA, PA., APRIL 25–26

Attendance: 276 Papers presented: 13

Prize	Recipient	Title of Paper	College
First	C. Williams	Automatic Applications of Turbohydraulic Transmissions	Princeton
Second	D. Q. Marshall	Release Pressure in Internal-Combustion Engines as an Index of Load Variation	Lehigh
Third	A. DeLong	Survey of the Cycle Industry	Drexel
Fourth	J. J. Owen	Modern Assyrians	Virginia
Fifth	A. E. Bates	Flow Patterns of Propeller-Type Fans	Pennsylvania

GROUP III—ALLEGHANIES STUDENT CONFERENCE, TORONTO, CAN., MAY 1–3

Attendance: 201 Papers presented: 10

Prize	Recipient	Title of Paper	College
First	J. B. Purdy	Air Conditioning for Railway Passenger Cars	Ohio State
Second	R. J. Rock	Air Streamlining of Ocean Ships	Case
Third	Dean Triplett	Prevention of Ice Formation on Airfoil Surfaces	Akron
Fourth	Vernon Gray	The Rocket Motor	Maryland
Fifth	J. R. L. Beane, Jr.	Welding of Steel Rails for Railroad Trackage	Geo. Washington

GROUP IV—SOUTHERN STUDENT CONFERENCE, ATLANTA, GA., APRIL 18–19

Attendance: 257 Papers presented: 15

Prize	Recipient	Title of Paper	College
First	F. C. Ullman	An Experimental Two-Stroke Cycle Radial Engine	North Carolina
Second	M. C. Brennan	Photoelasticity and Its Application to Engineering	North Carolina State
Third	Rankin Terry	Low-Cost Multi-Engine Industrial Power Plant	Kentucky
Fourth	F. K. Webb	Effect of Supercharging on Power and Economy of Internal-Combustion Engines	Georgia Tech
Fifth	A. J. Ferguson	Constant-Pressure Sugar-Cane Mill	Louisiana State

GROUP V—MIDWEST STUDENT CONFERENCE, MILWAUKEE, WIS., APRIL 18–19

Attendance: 300 Papers presented: 16

Prize	Recipient	Title of Paper	College
First	C. H. Dunn	Combined Effect of Abrupt Change of Section and Corrosion on Fatigue Strength of Low-Alloy, High-Yield, Strength Steels	Illinois
Second	A. N. Schrieber	Economics of Freight-Equipment Industry	Armour
Third	Donald McSorley	Humidity Insulation	Michigan State
Fourth	E. H. Weston	Proposed High-Speed Tank Locomotive Design	Northwestern
Fifth	D. J. LaBelle	Infiltration Through Windows	Detroit

GROUP VI—NORTHERN UNIT STUDENT CONFERENCE, OMAHA, NEBR., APRIL 15–16

Attendance: 109 Papers presented: 15

Prize	Recipient	Title of Paper	College
First	Fred Powell	Precision Measurement of Humidity	Missouri
Second	E. G. Smith	X-Ray Weld Inspection on High-Pressure Lines	Nebraska
Third	J. E. Passmore	Aluminum Foil as Insulation	Nebraska
Fourth	Guy Bixby	Plastics	Kansas
Fifth	J. J. Hill	A Similar Feature of the Internal-Combustion Process	Missouri
Sixth	J. L. Deffenbaugh	Improved Castings by Modern Design	Kansas State

GROUP VI—SOUTHERN UNIT STUDENT CONFERENCE, COLLEGE STATION, TEXAS, MARCH 28–29

Attendance: 140 Papers presented: 17

Prize	Recipient	Title of Paper	College
First	Lester Mueller	Cotton Burrs as an Insulating Material	Texas Tech
Second	W. A. Romaine	Performance Characteristics of Refrigerants	Oklahoma
Third	R. E. White	Use of Alloy Steels for Cracking Still Tubes	Texas A. & M.
Fourth	K. W. McLoad	Superposed Power Stations	Arkansas
Fifth	R. J. Bodemuller	Typical Natural Gas-Burner Designs	Texas
Sixth	L. T. Wright	Spray Towers for Air Conditioning	Texas
Seventh	Richard Ducker	Manufacture of Dry Ice by Sublimation	Oklahoma
Eighth	B. R. Miller	Heat Treatment of Steel	New Mexico
Ninth	L. J. Powers	Machine-Vibration Study	Texas Tech

GROUP VII—NORTHWEST UNIT STUDENT CONFERENCE, SEATTLE, WASH., APRIL 4–5

Attendance: 75 Papers presented: 11

Prize	Recipient	Title of Paper	College
First	Ivan Shirk	Determination of Torsional-Stress Concentration	Washington State
Second	R. R. Henderson	Differentiation of the Stress-Strain Diagram	Washington
Third	Bernard Carlson	Experimental Check on Gas-Engine Flywheel Theory	Montana State
Fourth	R. E. Hage	The Limiting Size of Airplanes	Washington
Fifth	Paul Harrer	A Low-Cost Pump for Irrigation	Montana State

GROUP VII—CENTRAL UNIT STUDENT CONFERENCE, FORT COLLINS, COLO., APRIL 11–12

Attendance: 76 Papers presented: 9

Prize	Recipient	Title of Paper	College
First	R. A. Bice	Engineer's Place in Modern Society	Colorado State
Second	E. E. Dawson	Recovery of Oil by Water Flotation	Colorado School of Mines
Third	K. L. Morrison	Creep in Steel at High Temperature	Colorado School of Mines
Fourth	Max Murray	X-Ray Equipment Use in Industry	Wyoming
Fifth	Henry Mattson	Trends in Petroleum Industry	Utah
Sixth	J. E. Fuller	Observations on Casting and Machining Small Aluminum Parts	Colorado

GROUP VII—SOUTHWEST UNIT STUDENT CONFERENCE, LOS ANGELES, CALIF., APRIL 18–19

Attendance: 142 Papers presented: 12

Prize	Recipient	Title of Paper	College
First & Second divided	Robert Parsons	Air Conditioning the Magma Mine	Arizona
	A. L. Stanley	Design of an Evaporative Air Conditioner	California
Third	G. Hofeller	Methods of Gas Analysis	California Tech
Fourth	Elliot Bonhan	Study of Fire Nozzles	California Tech
Fifth	M. D. Donovan	Noises Due to Operating Machinery	Santa Clara

Group I at Ithaca, N. Y., PRINCETON BRANCH has invited Group II to Princeton, N. J., CASE BRANCH hopes to do itself proud as host to Group III in Cleveland, O., TENNESSEE BRANCH will entertain Group IV in Knoxville, Tenn., LEWIS BRANCH is all set for Group V in Chicago, Ill., MISSOURI SCHOOL OF MINES BRANCH has invited Group VI (North Central) to St. Louis, Mo., TEXAS TECH BRANCH will tender southern hospitality to Group VI (Southwest) at Lubbock, Tex., NEVADA BRANCH is having Group VII (Pacific Southwest) out to Reno, Nev., COLORADO BRANCH expects to show Boulder, Colo., to Group VII (Rocky Mountain), and OREGON STATE BRANCH will be at home at Corvallis, Ore., to Group VII (Pacific Northwest).

J. E. Hannum Appointed Assistant Dean of Engineering

J. E. HANNUM, member, A.S.M.E., and a former member of headquarters staff of the Society, has been appointed assistant dean of engineering at Alabama Polytechnic Institute, Auburn, Ala.

Energy Supply Discussed at Vienna Sectional Meeting World Power Conference, Aug. 25–Sept. 5

NEARLY 200 papers from 21 countries were discussed at the Section Meeting of the World Power Conference, held in Vienna, August 25 to September 5, 1938. Eleven of these papers were prepared by authors in the United States.

The program of the conference was divided into five sections devoted, respectively, to supply of energy for agriculture, supply of energy for small-scale industries, supply of energy for household purposes, supply of energy for public lighting, and supply of energy for electric railways.

Portions of a survey of the subject matter, prepared in German by the Conference Committee in Vienna and translated into English by the United States National Committee, follow:

Agriculture

Rural energy supply and energy requirements in the different countries are determined essentially by the mode of living, the type of food, climatic conditions, and the type of settlement. Electricity is the most important form of energy in this field. The poor load factor of the different individual applications, resulting from their highly seasonal character, is counterbalanced by their great diversity throughout the year so that economic operation of the distribution systems can be achieved. Steam power and Diesel motors for threshing, wind motors and water wheels for pumps and irrigation are mentioned and valuable suggestions are made. For transportation of goods to and from the farm and for farming, the tractor becomes more and more important.

Animal power (horses and oxen) is prominent. Power for threshing is furnished by steam engines using mostly straw as fuel. For water supply the "Wies" motor is used. Government encouragement of rural electrification is governed by the economy of distribution systems. One can expect, therefore, that the progress already made in the field of rural electrification in the densely populated countries as compared to the sparsely settled ones will become more pronounced while the energy requirements in countries with sparse settlements will be provided by steam or Diesel engines, stationary as well as mobile.

There is an effort in all countries of the world for which reports are available to relieve the farmer of much of his drudgery and to attempt to counteract unfavorable climatic conditions by artificial means. There is an increased tendency, especially in the more progressive countries, to make greater use of the radio for weather and market reports leading eventually to greater use of energy.

Small-Scale Industries

Many of the papers describe the extent to which energy is used in small-scale industries in the respective countries, and stress the importance of providing as much energy as possible for this purpose and of promoting utilization apparatus. Also reported is motor horsepower per worker. The economic importance of small-scale industries is pointed out. Promotional rates are advocated. Competition between the different sources of energy is described.

A number of reports deal with encouragement of energy supply by government, ranging from outright subsidy of public-utility systems to simple legislative encouragement.

Commercial rates for electricity and gas are treated in detail with attention drawn to the Swedish block rates.

Some of the reports are devoted to large gas and electric kitchens showing the progress in this field. Other papers deal with special fields, for instance, energy supply for mills, dairies, restaurants, welding, the textile industry, and for electrolytic processes. One report demonstrates the advantage of modern methods of quarrying. In a paper from England the use of solid fuels in small-scale industries is discussed. One paper deals with problems of wiring in commercial installations and stresses certain standards for it. Finally there is a paper worthy of attention which is concerned with safety regulations for electric-power installations in small-scale industries.

Household Purposes

Subjects discussed in connection with the supply of energy for household purposes include loading of distribution systems through gas cooking, gas installations in Vienna apartment houses, and terms and regulations for the supply of gas, use of solid fuels in English homes, new Swedish kitchen stoves for solid fuels, modern Swedish gas appliances for households, use of continuously burning coal stoves, and the effect of climatic conditions on room heating in Czechoslovakia.

Many of the questions pertaining to electricity supply for households can be considered already answered but these problems still occupy the center of interest in nearly all countries. The reports submitted deal with questions raised in the technical program of the World Power Conference, i.e., questions of distribution and application of energy, rates, market analyses and canvassing, government encouragement of energy supply for households, and influence of taxation on rates. Some of these general national papers give an excellent picture of the conditions of the country and with their numerous tables and curves should give all those interested in these problems many new ideas. Papers dealing with rates lead as to number and size. Experiences with new types of domestic rates during recent years are described in great detail. Some papers on electric cooking add valuable material to the existing knowledge in this field.

Public Lighting

The various forms of energy supply for street and traffic lighting are discussed. A tendency to change from gas to electric lighting can be observed everywhere. Of great interest are the descriptions of the various designs for street-lighting installations, the question of supplying the energy through a separate system or through the general distribution system, and also some forms of time control. The increase in public lighting as evidenced from the reports will make it an important factor in the loading of stations.

Electric Railways

A number of reports discuss the question whether power for electric railroads should be supplied by their own generating stations, or by power companies and their distribution systems. Discussion is from the technical as well as the economic point of view. Lately there has developed a difference of opinion among technical experts concerning the power supply of railroads, depending on local conditions in the different countries. This question cannot be answered satisfactorily for all conditions. On the other hand it is generally agreed that power for street, city, and suburban railways, is supplied most economically by power companies. Several reports discuss thoroughly, with the aid of supporting data, the importance of traction in the energy requirements of a country, the parallel operation of railway generating stations with power companies, the relation between average and maximum demand (load factor), the effect of operating schedules on the load factor, and the specific energy requirements of the various types of electric railroads. The question of regeneration and its technical and economic practicability has lately been given increased consideration by various railroad operating departments. This fact has been brought out by several reports and is supported by valuable data based on experience as well as tests. Some reports also contain data on rate schedules applying to railroads, also on costs of energy when the roads generate their own power, or energy prices when they purchase it.

(*A.S.M.E. News Continued on page 794*)

Men and Positions Available

Engineering Societies Employment Service

MEN AVAILABLE[1]

GRADUATE MECHANICAL ENGINEER, age 24, single. Two years' experience in drafting and checking on heavy machinery. Desires position in aircraft or machinery plant. Location immaterial. Me-145.

MECHANICAL ENGINEERING GRADUATE, 23, single, Cornell, 1935. One year factory experience; 2 years' designing air-conditioning layouts; desires work leading to engineering position. Willing to change fields. Me-146.

MECHANICAL ENGINEER, age 44, graduate. Widespread experience railroad shop, metal fabrication, handling, labor and safety relations. Salary, location secondary to opportunity demonstrate ability, proved in past by responsible positions held. Me-147.

MECHANICAL ENGINEER, age 38, graduate. Experienced production control, laboratory testing, product design, marketing, installing, servicing of standard and per-specification equipment. Desires executive position with progressive concern or as consultant. Me-148.

GRADUATE ENGINEER, M.E. 1934, desires change; 26 years old, married. One year teaching; 3 years' testing experience with aircraft engines and propellers. Will consider teaching or engineering. Prefer East or South. Me-149.

[1] All men listed hold some form of A.S.M.E. membership.

A.S.M.E. Fall Meeting

Providence, R. I., Oct. 5–7

Thirty-Three Technical Papers

will be read at fifteen sessions on subjects in the field of machine-shop practice (six papers), rubber (four papers), jewelry (five papers), fuels (four papers), power (five papers), textiles (four papers), industrial instruments (one paper), iron and steel (two papers), and management (two papers)

Six Scheduled Plant Visits

to Brown & Sharpe Manufacturing Co., U. S. Rubber Products, Inc., Esmond Mills, General Electric Co., and Narragansett Brewery

Luncheon

Henry M. Wriston, president, Brown University, speaks Wednesday noon

Clambake at Pomham Club

the Hon. Louis Johnson, Assistant Secretary of War, speaker, Thursday evening

Headquarters

at Providence-Biltmore Hotel

MECHANICAL ENGINEER, honor graduate, Purdue, 1938. Specialized in production and personnel field; one year production work and 9 months' design experience. Desires opportunity in field of training and experience. Me-150.

MECHANICAL ENGINEER, 1936 graduate, married. Two years' with leading manufacturer electrical equipment, including factory-layout, cost-reduction, materials-handling experience. Interested financial as well as engineering aspect of industry. Me-151.

PLANT OPERATING AND INDUSTRIAL ENGINEER, graduate M.E., Rensselaer 1929. Experienced supervision and management control manufacturing, plant services, scheduling, costs, with diversified processes. Adaptable, aggressive, effective. May he consider your problems? Me-152.

MECHANICAL ENGINEER, technical graduate. Fifteen years' experience plant engineering, maintenance, power, equipment design and development, supervision layouts and installation, particularly food and chemical plants. Desires more responsible connection, New York preferred. Me-153.

MECHANICAL ENGINEER, heating ventilating, air conditioning; graduate engineer in electrical engineering; N. Y. State Professional Engineering License pending June examination; 8 years' experience in design and construction. New York City. Me-154.

PHILADELPHIA DISTRICT SALES MANAGER for nationally known organization handling any type of highly technical mechanical or chemical apparatus and industrial equipment; 14 years' contact with worth-while concerns Washington to New York. Me-155.

SALES ENGINEER, young, single, Christian. Experienced in selling heavy machinery, nonferrous castings, and mechanical power-transmission equipment. Desires sales position with manufacturing concern. Willing to travel. Me-156.

ENGINEER-EXECUTIVE, Ph.D., industrial-mechanical engineering and business administration. Experience includes executive management position, college professorships, and industrial consulting. Also familiar with industrial relations, duties of comptroller, plant management, market research, transportation. Me-157.

LICENSED PROFESSIONAL ENGINEER with wide experience in management, design, construction, and sales in power transmission and material handling, is available where his experience will be of mutual benefit. Me-158.

MECHANICAL ENGINEER, graduate. Business executive; practical fabricating background; excellent supervisory experience, designing, contracting, erecting, testing air-handling equipment and industrial-process systems. Ventilating, drying, cooling, humidifying, conveying, dust-collecting, exhaust installations. Me-159.

SALES ENGINEERING position desired by mechanical engineer, age 31. Now employed as chief inspector. Past experience includes refrigeration, purchasing, and some sales. Good knowledge of machinery and instruments. Me-160.

MANUFACTURING EXECUTIVE. Experienced supervisory and managerial capacities, plants, producing machinery, plastics, chemicals, metals, electrical products, automotive. Conversant all functions, their coordination. Leader, analytical mind. Background of industrial-engineering experience. Me-161.

MECHANICAL ENGINEER, young. Qualified to organize and supervise efficient plant-lubrication program, and head or assist power or maintenance department. Diesel plant, steam plant, refinery, and broad lubrication-engineering experience. Me-162.

EXECUTIVE-ENGINEER, age 36, married. Capable assistant to sales or manufacturing executive. Technical background, wide experience in responsible technical and manufacturing positions. Specialized in building materials, wood and its products. Me-163.

MECHANICAL ENGINEER, 1938 graduate, age 23, single, member of Tau Beta Pi. Experienced in hydrogenerator erection and machinist trade. Interested in hydro or steam work. Will travel anywhere. Me-164.

GRADUATE MECHANICAL ENGINEER, age 28, single. One and a half years as draftsman on steel-mill construction and one year as time-study engineer on wage-incentive plan; desires engineering position. Me-165.

GRADUATE MECHANICAL ENGINEER, 30. Six years experience in China in oil-station operation and engineering-sales work; desires connection Far East; speaks Chinese fluently. Knowledge of import and export procedure. Me-167.

MAINTENANCE ENGINEER desires charge mechanical, power departments of manufacturing concern. Holds Massachusetts first-class engineer's license. Good record in responsible positions with large industrial and utility concerns. Excellent credentials. Me-168.

POSITIONS AVAILABLE

MECHANICAL ENGINEER, age 25–30, with 2 to 5 years' experience in time-study work. Must be familiar with machine-shop practice and able to originate and use own formulas. Salary, $150 a month. Apply by letter. Location, New Jersey. Y-3232.

CHIEF MECHANICAL ENGINEER. Must have maintenance experience with mining company. Apply by letter. Location, South America. Y-3238.

DESIGNER with experience on production machinery. Apply by letter. Location, New York State. Y-3239.

ASSISTANT BUILDING SUPERINTENDENT, age 27–28, graduate mechanical or electrical engineer for industrial buildings. Must have boiler, elevator, building-equipment experience. Only engineer either native of or with experience in the South will be considered. Salary, $1800–$2000 a year. Apply by letter. Location, South. Y-3245.

FOREMAN with some experience in design of small mechanical parts and able to prepare his own working drawings from specifications fur-

(*A.S.M.E. News Continued on page 796*)

nished by research staff. Should be competent to supervise the construction of geophysical instruments and to direct staff of about 30 machinists and fitters. Apply by letter. Location, South. Y-3249.

GRADUATE MECHANICAL ENGINEER, age 28–32, for firm of consulting industrial engineers. Must have tact and ability to present clearly engineering facts and conclusions orally or in writing. Must have experience in steam-generating equipment. Apply by letter giving detailed statement of experience, education, personal data, salary required, etc., and enclosing recent photograph. Location, New York, N. Y. Y-3260.

FACTORY MANAGER preferably familiar with rubber and plastics for company manufacturing flexible tubing. Apply by letter. Location, New Jersey. Y-3263.

ENGINEER, young, technical graduate, preferably petroleum engineer with mechanical and metallurgical experience or mechanical engineer with oil-field experience, familiar with conditions encountered in deep-hole drilling. Actual knowledge of pipe manufacturing desirable as work deals largely with pipe and thread inspection. Salary open, depending upon man and amount of preliminary training required. Opportunity. Apply by letter giving details of experience and enclosing photograph. Location, California. Y-3265-R-7362S.

SALES ENGINEER, age 30–35, graduate mechanical or mining engineer to take charge of sale of such products as chlorination and filtration equipment, Diesel engines, pumps, construction equipment, fabricated-steel structures, valves and fittings, conveying equipment, paint and paint-spraying equipment, etc. Duties will also include preparation of layouts and estimates, supervision of installation of equipment sold, extensive travel in interior of country, and correspondence with principals in U. S. Must have broad general experience. Machinery-sales experience desirable, and knowledge import and export procedure. Able to speak and write English, Spanish. Apply by letter. Location, South America. Y-3278.

CIVIL ENGINEER, not over 30, with construction experience, preferably on docks, etc. Work will be to get in touch with consulting engineers in connection with specifying use of company's product. Apply by letter. Location, New York, N. Y. Y-3279.

GRADUATE MECHANICAL ENGINEER to teach industrial engineering in large organization. Must have practical industrial or engineering experience, as well as good theoretical engineering background. Such experience should have been in practical manufacturing problems and work in such fields as plant layout, production control, time, motion study. Apply by letter. Location, Middle West. Y-3290C.

DESIGNER for photographic equipment. Must be familiar with machine design, principles of photography and optics, electrical circuits and automatic machinery in general. Preliminary work will consist of research and patent investigation. Apply by letter. Location, East. Y-3293.

ASSISTANT PROFESSOR to teach power plants and thermodynamics. Must have Master's degree, and experience in practical work in power-plant field, or in teaching in fairly responsible capacity. Salary, $2500 a year. Apply by letter. Location, East. Y-3294.

CHIEF DRAFTSMAN for development department. Must be able to supervise drafting force of about 30 men; have knowledge of drafting-room practice and experience bills of material, specifications, and part numbers. Duties will be to set up rigid standards on drafting time required to do job and to schedule and check planned completion dates. Should also include experience in follow-up of schedules, together with experience in determining quality and quantity of production of draftsmen. Apply by letter. Location, New York State. Y-3311.

INDUSTRIAL ENGINEER, young, for production systems. Must be graduate mechanical engineer, and have several years' practical production experience. Salary, $40–$50 a week. Apply by letter. Location, New York, N. Y. Y-3312.

Candidates for Membership and Transfer in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after October 25, 1938, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references.

Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Reelection; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

ADAMS, CLARENCE H., Windsor, Vt. (Rt)
BECHTOLD, M. E., Indianapolis, Ind.
BELKNAP, ETHELBERT, New York, N. Y. (Rt)
BERSTEN MURRAY, New York, N. Y.
BORDEN, J. H., Philadelphia, Pa.
CONNOR, W. A., JR., Toronto, Ontario, Canada
DALTON, THOMAS N., Warren, Pa. (Re)
DEAN, JAMES W., Toledo, Ohio
DOSTER, HOWARD G., Wadsworth, Ohio
EVANS, BENJ. G., Halethorpe, Md.
HALE, PHILIP P., Toledo, Ohio
HEGGEN, ODVAR, Cohoes, N. Y.
FISHER, HOMER V., Los Angeles, Calif.
FRENCH, JOHN C., Balboa, C. Z.
JAIN, DEVENDRA K., Lahore, India (Rt & T)
KAMIJO, TSUTOMU, New York, N. Y.
LAMIE, A. J., Los Angeles, Calif. (Rt)
LUNDQUIST, ELMER C., Buffalo, N. Y.
MCKIEL, H. W., Sackville, N. B., Canada (Rt)
MILLER, CARROLL E., Windsor, Vt.
MOON, DORRIEN G., Savannah, Ga.
MUELLER, FRANK H., Decatur, Ill.
MULLALY, ARTHUR B., Interlaken, N. J.
NIELSEN, DONALD M., Foxboro, Mass.
REDWAY, ALBERT S., New Haven, Conn.
REED, ALBERT C., Washington, D. C.
SMITH, CHARLES G., Washington, D. C. (Rt)
THAYER, WM. WELSH, Santa Monica, Calif.
TRECKER, FRANCIS JULES, Milwaukee, Wis.
WAREHAM, JAMES KENNEDY, New Kensington, Pa.
WILSON, JOSEPH G., Berkeley, Calif.
WOOD, MARK E., New York, N. Y.
WOODBURN, JAMES, Louisville, Ky.
WORDEN, EDWIN S., JR., New York, N. Y.

APPLICATION FOR CHANGE OF GRADING

Transfers to Fellow

JACKSON, JOHN PRICE, New York, N. Y.
MACY, RALPH G., New York, N. Y.
PIGOTT, R. J. S., Pittsburgh, Pa.

Transfers to Member

COOPER, ALBERT H., Blacksburg, Va.
DOLEZAL, EDWARD, Bartlesville, Okla.
MEES, ROBERT T., Peoria, Ill.
PFEIFFER, FRANK F., Philadelphia, Pa.
WISLICENUS, GEORGE F., South Orange, N. J.

Necrology

THE deaths of the following members have recently been reported to the office of the Society:

AITKEN, SAMUEL, August 12, 1938
BROWN, MORTIMER C., August 21, 1938
DENMAN, BURT J., June 25, 1938
HERTZLER, S. P., April 19, 1938
HOBART, JAMES C., August 15, 1938
HOFFMAN, JAMES DAVID, August 13, 1938
HOLLENBERGER, THEODORE J., July 16, 1938
KELLY, TIMOTHY J., August 31, 1938
PAUL, JOHN WALLACE, May 23, 1935
STAHL, FRANK E., August 14, 1938
STAPLE, SYDNEY J., June 16, 1938
TRIBE, JAMES, August 13, 1938
TYLER, CHARLES C., February 21, 1937

A.S.M.E. Transactions for September, 1938

THE September, 1938, issue of the Transactions of the A.S.M.E., which is the Journal of Applied Mechanics, contains abstracts in the English language of papers presented at the Fifth International Congress of Applied Mechanics, Cambridge, Mass., Sept. 12 to 16, 1938. Published at the request of the Applied Mechanics Division, with the approval of the Committee on Publications and the Council of The American Society of Mechanical Engineers for the benefit of Society and Congress members.

•Keep Informed . . .

Available literature may be secured by addressing a request to the Advertising Department of MECHANICAL ENGINEERING or by writing direct to the manufacturer and mentioning MECHANICAL ENGINEERING as the source.

• NEW EQUIPMENT
• BUSINESS CHANGES
• LATEST CATALOGS

Announcements from current advertisers in MECHANICAL ENGINEERING and the MECHANICAL CATALOG

• NEW EQUIPMENT

Precision Oil Film Bearings

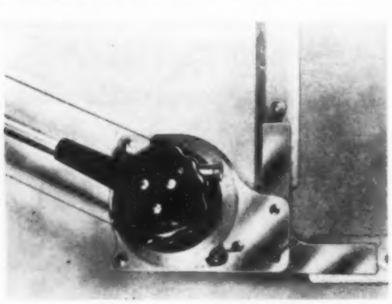
Designed to carry the load on an oil film to prevent metal to metal contact, a new bearing known as Fast's Precision Oil Film Bearing is being manufactured and marketed by The Fast Bearing Co., Hampden Ave. & 23rd Street, Baltimore, Md.

Each bearing functions as a self-contained centrifugal pump creating the most reliable and efficient lubrication system possible.

This design, the result of many years' research, development and test, is interchangeable with existing types of ball and roller bearings of the same series made to standard dimensions. It is made in two types, the Cylindrical for radial loads and the Spherical and Self-aligning for thrust or location bearing. Both types are made in a range of sizes up to about 6" bore and for bearing loads up to 21,000 lbs.

New "Touch Control" Drafter

What is described as one of the most important and significant developments ever offered in Drafting Machines has just been announced by the Charles Bruning Company, 100 Reade Street, New York—the new Bruning-Wallace Touch Control Drafter.

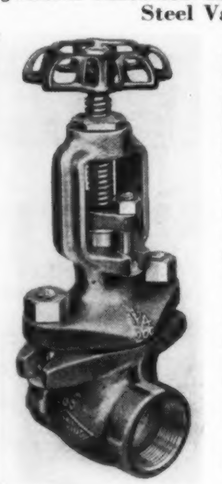


According to company officials, the new Drafter brings new speed, smoothness and accuracy to the drafting process. The new method of controlling the protractor head—known as "Touch Control"—assures utmost responsiveness of the machine to the draftsman's wish, and eliminates all fumbling or other waste motion in operating the machine.

The Touch Control button is located on the protractor head, where it is always conveniently under the draftsman's thumb. A touch, on this control button releases the head, allowing it to rotate freely to the desired setting. Simply lifting the thumb locks the head positively at the desired automatic index stop. A slight turn of the control button allows "free wheeling," enabling the head to rotate freely. With Touch Control, it is stated, the operator can concentrate on his work and is not required to pay undue attention to the operation of his machine. The thumb-latch has been eliminated.

The new Bruning-Wallace Standard Drafter is designed especially for the use of mechanical, architectural and structural draftsmen. The full circle protractor is graduated throughout in degrees, and numbered in each quadrant, from 0° to 90°. Automatic indexing stops are provided at 0°, 30°, 45°, 60°, and 90° in each of the four quadrants—corresponding to standard triangles. The double vernier reads to 5 minutes. The scale line-up adjustment permits the scales to be set accurately to correspond to lines previously drawn, instead of lining up the drawing to the scale.

Jenkins Corrosion-Resisting Stainless Steel Valves



Jenkins Bros. 80 White Street, New York, N. Y., introduces to industry the most advanced line of corrosion-resisting stainless steel valves available at the present time. By "Corrosion-Resisting Stainless Steel," is generally meant some combination of chromium and nickel with small additions of silicon, molybdenum, copper, columbium, titanium etc., the balance being iron. The expression, "18–8," for example, refers to an 18% chromium and 8% nickel content.

These new Jenkins Valves are regularly made of Copper 18–8 S and Copper 18–8 SMO, each having a carbon content limited to a maximum of .10% ($^1/_{10}$ of one per cent). Both are highly resistant to corrosion, but Copper 18–8 SMO is used under most severe conditions and is particularly adapted to sulphite pulp mills. It is safe to state that these two alloys will take care of almost ninety per cent of all corrosion-resisting requirements. In cases where neither of these valves can be recommended, valves of other alloys will be considered on special order.

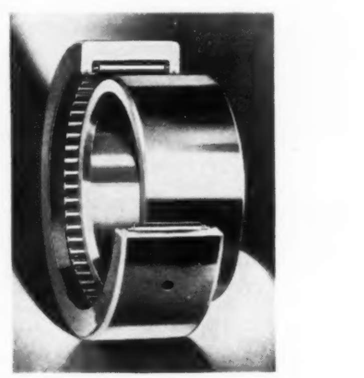
They are available in 7 different styles: solid wedge or double disc Gate Valves, union bonnet or bolted bonnet Regrinding Globe or Angle Valves, and bolted bonnet "Y" Valve; all either screwed or flanged, in sizes $^1/_2$" to 3".

Cup Point Set Screw

Cup Point Set Screws can now be supplied by Standard Pressed Steel Co., Jenkintown, Pa., with knurling all around the points. When turned into place the knurled edges effectively grip the shaft in such a manner that loosening or backing-off is absolutely impossible except by the application of a wrench. As there is nothing about these screws that can in any way harm the threads of the tapped holes it is possible to re-use the same screws in the same holes indefinitely and every time secure an equal degree of effective self-locking protection. There is a wide range of sizes available. Samples will be sent upon request.

New Bantam Bearing

A new type heavy duty needle roller bearing known as The Standard Quill Bearing has been announced by the Bantam Bearings Corporation of South Bend, Indiana. This bearing is the result of many years' experience in the manufacture of needle rollers for use in automotive transmissions, universal joints, diesel engine wrist pins and many types of heavy duty machinery. It is said to possess a number of outstanding features, some of which are as follows:



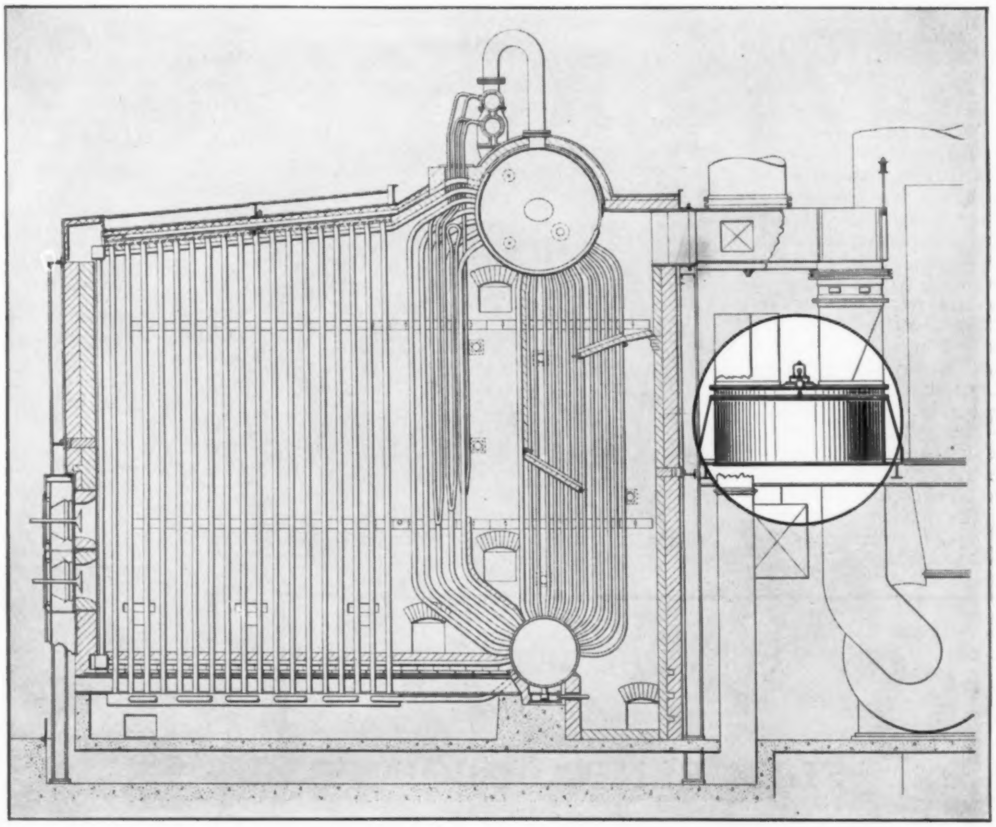
The ordinary assembly of outer race with hardened retaining rings, washers, stampings, etc., has been supplanted by a one-piece, rigid, channel-shaped outer race in which a full complement of small diameter rollers is firmly held. A Spring steel band is employed to maintain the rollers and outer race as a unit during assembly but is not called upon to carry any load while operating. The rigid rib surfaces of the outer race are accurately hardened and ground, thereby keeping rollers in perfect alignment. Rollers are correctly proportioned to the pitch diameter involved and are made with husky curvilinear trunnions. The load capacity is high. Space required is at a minimum.

The design is considerably simplified and all fragile parts have been eliminated. Assembly is very easy. The bearings are available either with or without inner races. To render prompt service Bantam is carrying these Standard Quill Bearings in stock in a complete range of sizes for shafts from $^3/_4$" to 5". Through large quantity pro-

Continued on Page 18

ADAPTABILITY

Ljungström Air Preheaters Are Easily Adaptable To All Sizes and Types of Boilers



Spreckels Sugar Company
Woodland, California

Ljungström air preheaters are built in standard sizes to meet all requirements. The design permits their application to any type of boiler and for all capacities.

The Ljungström air preheaters installed in the plant of the Spreckels Sugar Company at Woodland, California, are applied to two boilers, each generating 100,000 lb. of steam per hour. They furnish air to the furnace at 396 deg. F. and reduce the exit gas temperature to 375 deg. F.

THE AIR PREHEATER CORPORATION
Under the Management of THE SUPERHEATER CO.
60 East 42nd Street New York, N. Y.

duction the cost has been brought down to a low figure.

According to Mr. A. H. Frauenthal, General Manager of Bantam, they have in the past years designed and made thousands of these unit type Quill Bearings for specific purposes but until recently had not developed a design sufficiently dependable to offer for general use. Every sound engineering criticism that has arisen in the past years has been eliminated in the present structure. Bantam has just issued a special bulletin describing these bearings in full which gives complete engineering facts. Users of bearings for heavy radial loads are invited to write the Bantam home office at South Bend for Bulletin No. 103N.

General Electric Develops Low-Cost Resistance Welding Process

General Electric engineers have developed a low-cost resistance welding process of an electronic type to replace expensive soldering operations in the manufacture of such devices as radio sets, watches, small meters, industrial control devices, railway signal equipment, and business machines.

A current of several thousand amperes flows in the secondary circuit of the welder for a half-cycle which is precisely timed by an ignition tube and its associated control circuit. This control circuit includes a dial for regulating the heat by the phase-shifting method. The amount of heat is accurately determined by the duration of current flow; maximum heat is obtained with a current duration of slightly more than $^1/_{120}$ of a second. The welding transformer and its associated equipment are suitably enclosed.

On other electrical devices, as well as on radio sets, tongs are used with the equipment in the welding of solid or stranded wires to terminals. Likewise, a suitable bench welder can be utilized to weld small studs (.010 in. to .050 in diameter) to flat surfaces with little or no marking on the opposite side of the sheet of metal. Similar equipment is suitable for the spot-welding of thin sheets of various alloys with little or no oxidation or discoloration.

Link-Belt Unmounted Roller Bearings

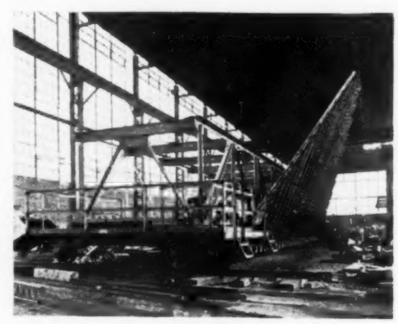
Of likely interest to designers and builders of machinery equipment is the announcement that Link-Belt Company, Chicago, has placed on the market a very complete line of Link-Belt Shafer radial-thrust single-row and double-row roller bearings in the naked or unmounted form, and that a new Book No. 1652, 12 pages, complete with engineering data for figuring applications, has been prepared, to cover the subject.

The text of the book stresses—1. Free rolling action with unimpaired loading capacity, even in the presence of shaft deflection or misalignment, is assured. 2. No provision for misalignment need be made in the bearing housing or mounting. 3. Thrust capacity is provided by the roller and raceway shapes and by the angular position of the curved rollers between curved races. 4. Radial or thrust or any combination of radial-thrust loads will be carried equally as well and on the same full contact area under all conditions of alignment. 5. There is no possibility of rollers pinching or binding, and no need for auxiliary means of taking the thrust.

The new book gives dimensions, weights, load ratings at 500 r.p.m., and list prices, for both single-row and double-row bearings. Engineering data, such as determination of radial load; load ratings; modifying factors; life factors; operation factors; speed factors; and formulae and examples covering all types of loading, also are included. A copy of this new Book No. 1652 may be obtained by writing to Link-Belt Company, Chicago, Philadelphia, Indianapolis or other office.

New Reclaiming Machine

The machine illustrated is a Robins-Messiter Reclaiming Machine assembled in the factory before shipment to a blast furnace plant in England. Its purpose is to reclaim ore from a storage pile which has been built up in layers of predetermined proportions of different grades or kinds of ore. Such a storage pile is built up by a moving tripper on an overhead belt conveyor discharging layer after layer of the desired ores until a complete pile or "bed" of triangular cross section is built.



The Reclaimer runs on rails located at the toes of the storage bed and the large triangular "harrow" shown at the right of the picture rests against the sloping end of the triangular section bed. This harrow carries a large number of spikes projecting into the surface of the ore bed and has a slow movement back and forth across the pile so that the surface is scratched or agitated and the loosened ore from all parts of the surface flows down in a uniform mixture as the reclaimer moves slowly but powerfully forward.

The loosened ore, representing a perfect blend of all the layers in the bed, is conveyed to one side by a scraper conveyor consisting of a series of plows mounted on a heavy chain and supported under the front of the reclaimer frame. At one side of the ore bed a belt conveyor, installed in a trench, carries the reclaimed ore to the furnace skips.

The propelling mechanism for moving the reclaimer into the ore bed is of a slow but variable speed in the control of an operator who has available a higher speed of travel for retreating after a bed is reclaimed. This retreating travel places the reclaimer on a transfer car which moves it to another storage bed.

Continued on Page 20

From Kitchen Scales to Helmets–

Plastics Headquarters Aids Design and Production

Handsome housings for kitchen scales and many other products are made from Bakelite Molded.

Tough, light-weight safety helmets of Bakelite Laminated withstand blows and moisture.

THE VARIETY of manufactured products now made to advantage with Bakelite plastics is practically unlimited. Bakelite Plastics Headquarters offers so many different materials for your selection, that articles as widely dissimilar as kitchen scales and construction helmets . . . or toy whistles and oil-well valves . . . are improved through their use.

To aid in the styling of your products, Bakelite thermosetting and thermoplastic materials provide a complete range of colors in opaque, translucent and transparent effects.

Severe service requirements may be met through the wide assortment of special Bakelite materials with unusual resistance to chemicals, mechanical stresses, heat or other service hazards.

From a production angle, Bakelite plastics frequently offer important economies. Intricate shapes may be more readily formed; assembly processes are simplified, and separate finishing often becomes unnecessary.

Whenever you are considering the use of plastics, consult Bakelite Plastics Headquarters *first.* There you will obtain the benefit of unbiased, impartial engineering service, assuring you maximum benefits in design and production. Write for Portfolio 32 of reference data.

BAKELITE CORPORATION, 247 PARK AVENUE, NEW YORK, N.Y.

BAKELITE CORPORATION OF CANADA, LIMITED, 163 Dufferin Street, Toronto, Canada *West Coast:* Electrical Specialty Co., Inc., Los Angeles and San Francisco, Cal.

BAKELITE

REGISTERED U. S. PAT. OFF.

The registered trade marks shown above distinguish materials manufactured by Bakelite Corporation. Under the capital "B" is the numerical sign for infinity, or unlimited quantity. It symbolizes the infinite number of present and future uses of Bakelite Corporation's products.

PLASTICS HEADQUARTERS

• Keep Informed
Continued from page 18

Similar Reclaimers have been in use for many years at copper smelters in the United States, South America and the Belgian Congo and they are now finding a wider field in the handling of iron ore.

The builder is the Robins Conveying Belt Company of New York.

"Buffalo" Power Feed Drill

Buffalo Forge Co., 148 Mortimer Street, Buffalo, N. Y., announces their new No. 16 Power Feed Drill. After interviewing tool engineers, production engineers, foremen and operators in many manufacturing plants, "Buffalo" engineers designed the No. 16 Power Feed. Bulletin 3122 describes it fully.

New Furnace Pressure Controller

The Brown Instrument Co., 4486 Wayne Ave., Philadelphia, Pa., announces the development of their Air-o-Line Furnace Pressure Controller. Long past its pioneering stage, this instrument is applicable for controlling any pressure in the range from $-5.0''$ H_2O to $+5.0''$ H_2O.

The Controller, Fig. 1, is essentially a sensitive, inverted-bell type draft indicator combined with the well-known Brown Air-o-Line Control Unit. Automatic reset and fully adjustable throttling range prevents the furnace pressure from lining out at some point other than the control point and eliminates over-correcting and cycling.

This instrument has consistently held furnace pressures within plus or minus .002 inches of water on a scale span of 0.2 inches of water. Not only is it accurate but it is practically instantaneous in operation, as the pointer will move 10% of the total range in one second, and 100% of the total range in three seconds.

The Air-o-Line Furnace Pressure Controller is adaptable to installation on all types of furnaces, stills, kilns, ovens and other similar equipment where very low differential or static pressure must be maintained.

• BUSINESS CHANGES

Foundry Improvements

Construction of additional foundry building space has recently begun at the Ansonia (Connecticut) plant of Farrel-Birmingham Company, Inc. The new building will add 4,000 square feet of floor area as part of a program of rearrangement of the Ansonia foundry department for increased efficiency and output.

Included in the new equipment to be installed is a 15-ton traveling crane, a large molding machine and a modern sand handling system for the elimination of dust and for reclaiming sand from molds used in the Randupson process.

The new construction and rearrangement will be completed by December. It is expected to provide not only improved facilities for greater efficiency and larger output but also to decrease congestion and improve working conditions.

Continued on Page 22

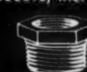
CRANE SCREWED FITTINGS FOR POWER PLANTS AND FACTORIES

Crane's line of fittings includes not merely the few hundred types and sizes in most common use, but a total of more than 10,000 separate and distinct items in cast and malleable iron.

ELBOWS—90°, 67½°, 60° 45°, 30°, 22½°, 11¼°, and 5⅝° Street, Long Sweep, Side Out let, Drop, Hub Vent

TEES—Service, Four-Way, Dro Tees, Long Sweep, Doubl Sweep, Wash Tray

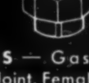
COUPLINGS—Right Hand, Righ and Left, Half (Also Wrough Iron), Reducers, Increasers



BUSHINGS—Outside and In side Hexagon, Face, Eccentri Double Tapped

PLUGS—Square Head, Soli Countersunk, Bar, Barrel

NIPPLES—Close, Short, Lon Tank



UNIONS—Gasket Typ Ground Joint, Female, Male an Female, Air-Pump

UNION FITTINGS—Male an Female, 90° and 45° Elbow Tees with Union on Run or Outl

A CRANE FITTING FOR EVER PURPOSE—The screwed fittin shown above are only a few the scores of different typ and modifications. The comple Crane line includes banded a plain patterns, black or galva ized, in a wide range of straig and reducing sizes; in four pr sure classes in malleable ir and five in cast iron.

$99\frac{9{,}996{,}551}{10{,}000{,}000}\%$ OF CRANE SCREWED FITTINGS ARE FOUND FIT

Last year, out of the millions upon millions of Crane screwed fittings sold, only one in every 290,000 was reported unusable. Striking proof that—in fittings as in valves—

IT'S WHAT'S INSIDE THAT COUNTS!

CRANE VALVES • FITTINGS • PIPE PLUMBING • HEATING • PUMPS

CRANE CO., GENERAL OFFICES: 836 S. MICHIGAN AVE., CHICAGO, ILLINOIS

NATION-WIDE SERVICE THROUGH BRANCHES AND WHOLESALERS IN ALL MARKETS

• Keep Informed . . . *Continued from page 20*

Engineering work on this project is being handled by the company engineers in conjunction with O. D. Conover Co., foundry engineers. The construction contract was let to Max A. Durrschmidt, Inc., of Derby, Conn.

• LATEST CATALOGS

Instruments for Remote Control

In a new bulletin recently published by The Bristol Co., 21 Bridge Street, Waterbury, Conn., there is a brief description of Bristol's Metameter System for Telemetering and Remote Automatic Control. This system is illustrated by photographs and chart records, which give a few of the interesting facts regarding an installation of these instruments for the Remote Automatic Control of Gas Distribution Pressure. The instruments used, automatically maintain the pressure in a gas distribution system at a constant value, regardless of load variation.

Adsco Heat Economizers

Building owners, schools, institutions and manufacturers using hot water for domestic purposes or processing work would be interested in the new pages that have been added to the ADSCO Bulletin No. 35–76 on ADSCO Heat Economizers.

By running the hot condensate from the return lines through an ADSCO Heat Economizer to preheat the domestic cold water supply, it is possible to secure full heat value from the steam and at the same time provide all or an additional amount of hot water for domestic or processing purposes.

The bulletin illustrates two of the many heat economizer applications and contains two charts—one whereby the amount of economizer heating surface can be determined and another that indicates the final temperature of the domestic water after passing through the economizer, based on varying condensate inlet temperatures. A copy of Bulletin No. 35–76 may be obtained by addressing the American District Steam Co., North Tonawanda, N. Y.

J & L Automatic Thread Grinding Machine

Jones & Lamson Machine Co., Springfield, Vt., have ready for distribution a new 20-page illustrated catalog entitled "J & L Automatic Thread Grinding Machine." The catalog describes the machine and attachments and illustrates the various forms of threads which can be ground.

New Combustion Control Bulletin

A 32-page bulletin "Bailey Meter Control" describing the application of the Bailey Steam Flow-Air Flow Automatic Readjustment Type of Air-Operated Combustion Control has just been published by Bailey Meter Company, 1026 Ivanhoe Road, Cleveland, Ohio.

In addition to describing and illustrating the various elements of the control system, the bulletin explains fundamental principles involved in controls, both for boilers fired with stokers and for boilers fired with fuels in suspension. Several actual installations are shown diagrammatically and illustrated with installation photos.

A large saving in fuel economy is claimed for this system which automatically maintains the desired fuel-air ratio at all times without the necessity of periodic attention and manual readjustment by boiler operators.

Other advantages claimed for Combustion Control are: increased safety of operation made possible by removal of the human element and the use of interlocks. Reduced boiler and furnace maintenance which results from the control's continuous action tending to hold operating conditions and factors at the values for which the steam generating unit was designed.

Millivoltmeter Pyrometers

A complete line of Millivoltmeter Pyrometers is described in a new bulletin No. 488, recently published by The Bristol Company, 21 Bridge Street, Waterbury, Conn. In this publication, 12 pages of useful information is given regarding the construction and operation of Bristol's Millivoltmeter Pyrometers in all models—a type of Pyrometer built by this instrument manufacturer for some 40 years. Data concerning the available ranges and drilling dimensions are also included. Several scales are reproduced in actual size. This line of Millivoltmeter Pyrometers includes: (1) Indicator Controllers, with Enclosed Mercury Contacts or Solid Metal-to-Metal Contacts, (2) Single Point Indicators, and (3) Multiple-Point Indicators with Rotary Switch. These operate with standard thermocouples or Bristol's Ardometer Radiation Pyrometer Unit.

COMING MEETINGS AND EXPOSITIONS

For the next three months

OCTOBER	
5-6	American Management Association, 1938 Conference on Office Management, Hotel Pennsylvania, New York, N. Y.
5-7	The American Society of Mechanical Engineers, Fall Meeting, Providence, R. I.
10-12	American Gear Manufacturers Association, 21st Semi-Annual Meeting, Skytop, Pa.
10-14	National Safety Council, Silver Jubilee Congress, Stevens Hotel, Chicago, Ill.
Wk. of 10th	American Gas Association, Annual Convention, Atlantic City, N. J.
12-14	American Society of Civil Engineers, Fall Meeting, Rochester, N. Y.
14-16	Second International Aerobatic Competition and St. Louis Air Races, St. Louis, Mo.
16-21	American Welding Society, Annual Meeting, Detroit, Mich.
Wk. of 17th	American Society for Metals, Annual National Metal Congress, Detroit, Mich.
NOVEMBER	
9-11	American Institute of Chemical Engineers, Philadelphia, Pa.
14	Society of Automotive Engineers, Annual Dinner, Commodore Hotel, New York, N. Y.
14-18	American Petroleum Institute, 19th Annual Meeting, Stevens Hotel, Chicago, Ill.
17-19	National Machine Tool Builders' Association, Fall Meeting, Hotel Homestead, Hot Springs, Virginia.
DECEMBER	
5-9	The American Society of Mechanical Engineers, Annual Meeting, New York, N. Y.
6, 7 & 8	American Society of Refrigerating Engineers, 34th Annual Meeting, Hotel Commodore, New York, N.Y.
27-28	Institute of Aeronautical Sciences, Technical Meeting, Richmond, Va.
27-31	American Association for the Advancement of Science, Winter Meeting, Richmond, Va.